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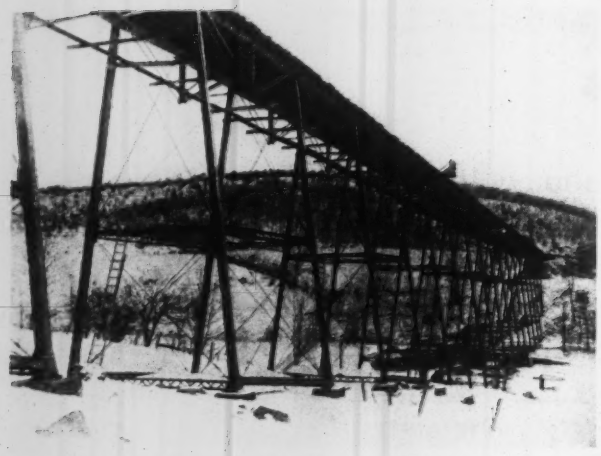

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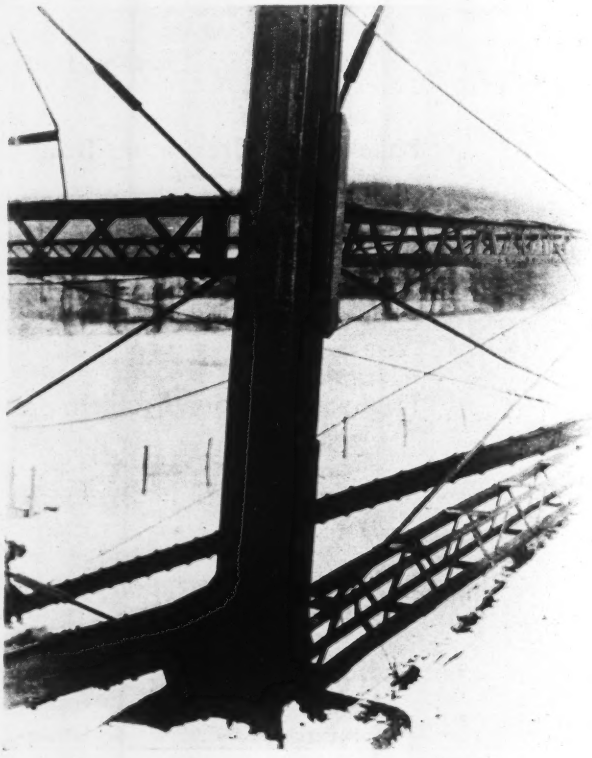

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The U. S. Coast and Geodetic Survey

A View of Its Activities

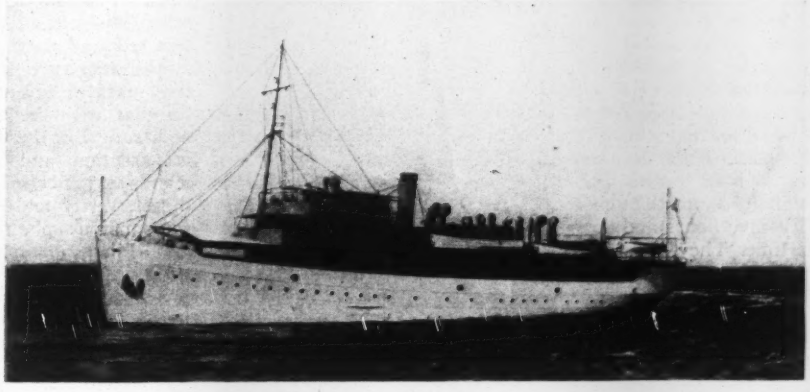
For more than a century this agency of the Department of Commerce of the federal government has been providing accurate nautical charts of our shore lines and creating a primary system of geographic control

PRECISE determination is honored by all engineers as the hall-mark of their profession. Indeed, it was the accurate determination of forces and dimensions made possible by the growth of the physical sciences that in the early days transformed engineering practice from an art to an applied science. But in no sphere of engineering activity are the strict requirements of precision more completely observed than in the work done by the U. S. Coast and Geodetic Survey. Approximations that might entirely satisfy the practical needs of a particular engineering project cannot be countenanced by this service, for its work is basic and must be precise.

The duty of the Survey is to provide the basic geographic framework for the entire country and to prepare nautical charts to guide mariners safely through the complex of shoals and channels comprising our shores. For more than a century it has been engaged in that work. During that long period our country has grown in area, and thousands of miles have been added to our coast line; vessels have undergone sweeping changes in size and speed; and the bars and shoals that make navigation hazardous have shifted with the tides and currents. Yet, because he has no doubts of the accuracy of the chart before him, a shipmaster today confidently guides his cargo through hazardous waters into a port he has never entered before.

The data necessary for making a nautical chart or a map are embraced in several different field processes. The first of these is the control survey that furnishes the framework for all charting of the coasts and mapping of the interior.

Fig. 1—The Coast and Geodetic Survey ship "Hydrographer," a fully equipped surveying vessel that can make accurate hydrographic surveys in a dense fog.



Geodetic control surveys

Control surveys include triangulation and traverse, geodetic astronomy, precise levels and gravity measurements. Engineers dealing with projects within a limited area find geodetic methods too burdensome except in the case of alignment of a long bridge or tunnel. However, if they deal with large areas, other methods will not suffice. They are essential to the creation of a geographic framework for an entire nation.

The French Revolution was undoubtedly responsible for the early start of geodetic surveys in the United States. When France, in 1790, adopted the meter as the unit of length and defined it as one ten-millionth of a quadrant of the

earth, other countries were stimulated to measure arcs of triangulation from which the length of the quadrant might be computed. In this endeavor it was found that such triangulation afforded the only really satisfactory framework on which to base the construction of mariners' charts or maps covering large areas. Ferdinand Haseler, in organizing the Coast Survey, adopted it as the method of control. The small beginnings of his day, control work done chiefly for the purpose of furnishing accurate charts of New York and other Atlantic Coast ports, were the first parts of a framework which now spans the country and extends to all its borders, controlling both the charting of the coast and the mapping and engineering work of the interior.

The value of coordinated geodetic surveys was well exemplified a few years ago in southeastern Alaska. Because of the large area and the urgent demand for scattered local surveys, especially along the coast, it had become necessary to establish local triangulation data. Due to observational errors and the deflection of the vertical, these surveys, when later extended and brought together, would not fit. The extension of a comprehensive triangulation system permitted an adjustment that easily reconciled all differences.

Another example of the need for great precision is afforded by the result of the triangulation connecting the north and south shores of Puerto Rico, only 45 miles apart. The distance as given by the earlier charts was found to be one mile too short. This was due to the fact that in the astronomical determinations on which the earlier surveys were based no account had been taken of the deflection of the vertical. Since on each coast there are high mountains on one side and a deep ocean on the other, the relative deflection of the vertical amounts to 56 seconds and accounts for the mile difference.

With 34,000 miles of triangulation in existence and with additions of 3,400 miles each year, and with about twice as many miles of first-order levels, a large part of the United States is already within easy reach of points whose latitude, longitude and elevation are precisely known. Recently a party covered 200 miles in a single month, having occupied 54 stations. This rapid progress has been made possible through the development of more efficient instruments and appliances, such as the Parkhurst theodolite and the Bilby portable steel tower, both developed by the Survey. These towers, having an average height of more than 100 ft., can be erected in five hours and taken down in half the time. They comprise an inner and an outer structure arranged so that the inner tower carries the instrument and the outer the observer.

With the extension of triangulation into more developed country, stations

Fig. 2—On Meades Ranch, Kansas, there is located the basic triangulation station for the United States, Canada and Mexico. The North American datum is defined in terms of the latitude and longitude of this station. It is marked by a bronze disk in a heavy concrete monument, the top of which is flush with the ground surface.

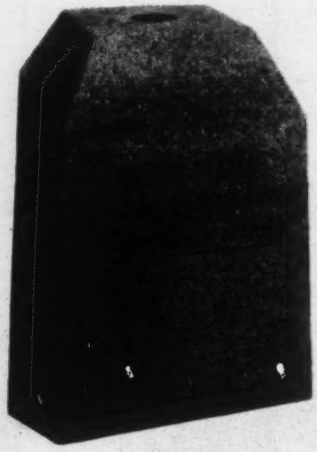
are being brought into closer reach of the engineer each year. They are also made more easily adaptable to his use by a mark at each station visible from the ground and accurately determined in azimuth.

Gravity measurements made by the survey play an important part in determining the dimensions and shape of the mathematical spheroid that most nearly approximates the shape of the earth. They also have other uses of an economic or scientific nature. By locating buried geological formations of abnormal density they may aid in the search for oil or minerals. They may be useful in earthquake studies by showing where the earth's crust is in a state of strain because of lack of equilibrium. Geologists are able to make use of gravity results in their work of interpreting geological history from the tectonic viewpoint.

Hydrographic surveys

Surveying the coasts of the United States and its possessions with the accuracy and detail required for the preparation of modern charts is an en-

Fig. 3—Basic benchmarks are used to preserve the datum of elevation, determined by a long series of tidal observations.



gineering project of the first magnitude. For although lights, beacons, radio stations and other aids to navigation dot our coasts, the mariner's basic guide is the nautical chart.

More than a picture of land and water areas, the chart is really an instrument of navigation on which the navigator plots his bearings, scales distances and courses and determines not only his position but the course to be followed to the next headland or landmark. It is an official document in which the mariner must have implicit confidence, and all the "legend and lore" of the sea cultivates this feeling. By well established precedent no personal responsibility rests on the master if his vessel gets into trouble because of errors in the chart; but if he puts his trust in unofficial statements or drawings, his responsibility is heavy. In case of accident, his license may be revoked.

A chart that was adequate a generation ago is practically useless to modern vessels of high speed and deep draft. Detailed surveys have always been expensive, and in the days when 24 ft. was considered a deep draft the surveys in areas outside of this critical depth were made with less detail than is now found to be required. When vessels were slow, detailed surveys of great accuracy were required only a few miles off the coast, since means for determining positions accurately were not available. But with the introduction of higher speeds, means for determining position when at greater distance from shore were developed, and this in turn necessitated more detailed surveys of the offshore areas. Further, the conditions pictured on the chart are not unchanging. Sands shift and artificial improvements are created. The mariner looks to the chart for the positions of lights and other aids as well as for information regarding limits and depths available in dredged channels. These varying conditions must be surveyed and charted. In the vicinity of many of our busier ports the changes are many and radical, and frequent surveys and new editions of the charts are required to keep up with the many changes. Full advantage is taken of surveys by other organizations, and a constant stream of maps, blueprints and other information flows into headquarters from all parts of the country.

The construction of the charts from this mass of information requires men familiar with the needs of the mariner and trained in the technicalities of chart construction and production. It demands experienced cartographers, who digest, verify and compile this mass of information; photographers, engravers and lithographers, who produce the printing plates with exacting accuracy; pressmen, who print the chart with the perfection commensurate with so important a document; draftsmen, who make the final additions to each copy by hand from information received

after printing; and a distributing organization with agencies in all important ports, to see that the latest additions are available to the mariner.

The varied character of the surveys required for chart construction have resulted in the development of what might be called the "amphibious engineer." Not only must he be able to carry on triangulation or precise leveling on shore, but he must be a thorough seaman and capable navigator so that he can command a surveying vessel. In both cases he must be familiar with special apparatus, some of which is based on the latest developments in physics and electrical engineering. This is especially well exemplified in the recent survey of Georges Bank.

East of Cape Cod there is an extension of submerged land twice as large as the state of Massachusetts, the eastern part of which is known as Georges Bank. All of this is of moderate depth, and some is dangerously shoal. Lying as it does on the principal transatlantic steamer tracks, it is crossed annually by thousands of vessels. The large liners, in order to maintain their regular schedules, are forced to pass in proximity to dangerous shoals in a region of strong currents and thick fogs.

The equipment and methods of earlier surveying vessels were such as to make a satisfactory survey of such a region impossible, and many difficult problems had to be solved before the accurate charts now under construction became possible. Accuracy and dependability are indispensable because many vessels are now equipped with echo-sounding apparatus and may use the bottom configuration as shown by the charts as an aid in following a safe course.

Echo sounding, both as to apparatus and methods, was well developed before this survey was undertaken. However, the most accurate sounding that can be taken is useless if its position is in error. As a basis for position determination the first thought was naturally to use triangulation, but triangulation out of sight of land was a startling idea. However, not only was the triangulation successfully accomplished, but for the first time no attention was paid to intervisibility of the objects. Some of the work was done in a dense fog. The plan followed was to place buoys at suitable positions to form good triangles. Then, instead of measuring angles, length measurement was used entirely. The measurements were made by radio-acoustic ranging, a method that had been perfected and used satisfactorily on the Pacific Coast.

Radio-acoustic ranging consists of measuring with high accuracy the time of travel of a sound wave along the line whose length is to be determined. At one end of the line a small bomb of TNT is exploded under water; a hydrophone is located at the other end. The vessel firing the bomb is equipped with an apparatus for recording both the time of firing and the time of receipt of a radio signal. The vessel or shore station to which the hydrophone is connected has apparatus for converting the incoming sound into a radio signal, which is instantly transmitted to the first vessel. By measuring the time of travel of the sound the distance between the bomb and the hydrophone can be computed from the known velocity of sound through the sea water. By this method the distances between the buoys are determined.

A station ship is then anchored near each of two buoys which are fitted with hydrophones. The surveying ship proceeds along the line to be charted, firing bombs at intervals. The position of each bomb is fixed by intersection of the arcs from the two buoys. At the same time echo sounding determines the water depth at each point. The survey proceeds rapidly. In the case of the survey of Georges Bank and vicinity, 35,000 square mile were surveyed and 200,000 soundings were taken in a comparatively short time. The accuracy of the results has been tested among other ways by having sounding lines cross at right angles. Except in very irregular bottom the depths agree closely.

In the usual path of liners a number of submarine valleys have been found that can readily be identified by echo sounding. They are unusually helpful to navigation. The survey of Georges Bank has already paid for itself many times over by making possible the shortening of time of liners with safety and by contributing to the safety of vessels crossing the banks in the coastal trade. Further, fishing charts have been specially prepared to aid the fishing industry through more exact knowledge of depth and character of bottom. Geologists have followed the survey closely, as it aids them in studying the difficult geological problems related to the origin of the bank and of its submarine valleys, some of which rival in depth the Grand Canyon.

Tides and tidal planes

The necessity for tide observations becomes apparent in connection with the charting of the coast, for the boundary between land and sea shifts continuously landward with the rising tide and seaward with the falling tide. Furthermore, since the depth of the water at any point is constantly changing under the influence of the rise and fall of the tide, the soundings made in any region must be referred to a common stage of the tide or, in other words, to a definite datum plane. But although it was begun as an incident to hydrographic surveys, tidal work has now assumed large porportions. This expansion became necessary to meet both the problems encountered in its own work and the demands made by other agencies and the public at large. Quite apart from the closely related work dealing with tidal currents, the purposes now served may be classified broadly under the two heads of tide predictions and datum-plane determinations.

In our textbooks on physical geography the tide is presented as a simple phenomenon arising from the attraction of the sun and moon upon the earth. But when we come to deal with the actual tide the matter is not so simple. While arising from the attraction of the heavenly bodies, the influence of the varying sizes and shapes of the ocean basins and dependent seas so profoundly modify the theoretical tide that one wonders whether moon or sun have anything to do with it.

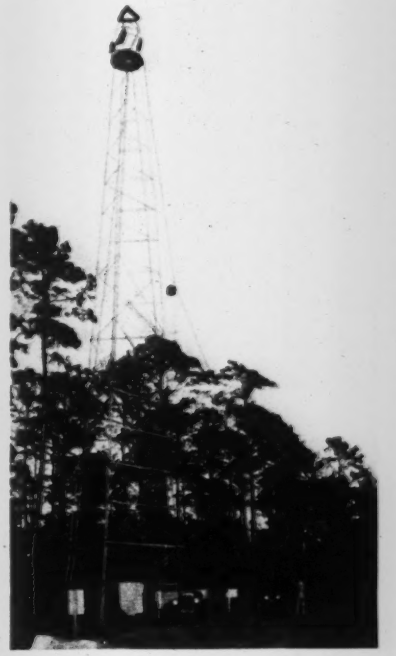


Fig. 4—One of the Bilby steel towers used by the Survey in its triangulation work. This one is 103 ft. high. The inner tower supports the instrument, and the outer tower supports a platform for the observer.

Each point seems to have tide characteristics little resembling those at other points. At many places the rise and fall is less than a foot, while in the Bay of Fundy it is between 40 and 50 ft. In New York harbor there are two high and two low waters each day, while in Pensacola Bay there is only one high and one low water each day. At Galveston there are two high and two low waters each day for part of the month and only one high and one low water during other times. At Seattle the two high waters of the day are much alike, while the two low waters may differ by as much as 8 ft. or more. At Honolulu, on the other hand, the two low waters of each day are alike, while the two high waters differ; and at San Diego both the high waters and the low waters of each day show marked differences.

To reduce this complex phenomenon to an orderly system is clearly not a simple matter. That the problem has been solved, however, is evident from the fact that the Coast and Geodetic Survey by means of its well-known tide-predicting machine is able to predict the tides for years in advance for any part of the earth and thereby is able to produce the tide tables familiar to all who live along the coast.

To the engineer, however, the problem of datum-plane determination is of more immediate importance than tidal

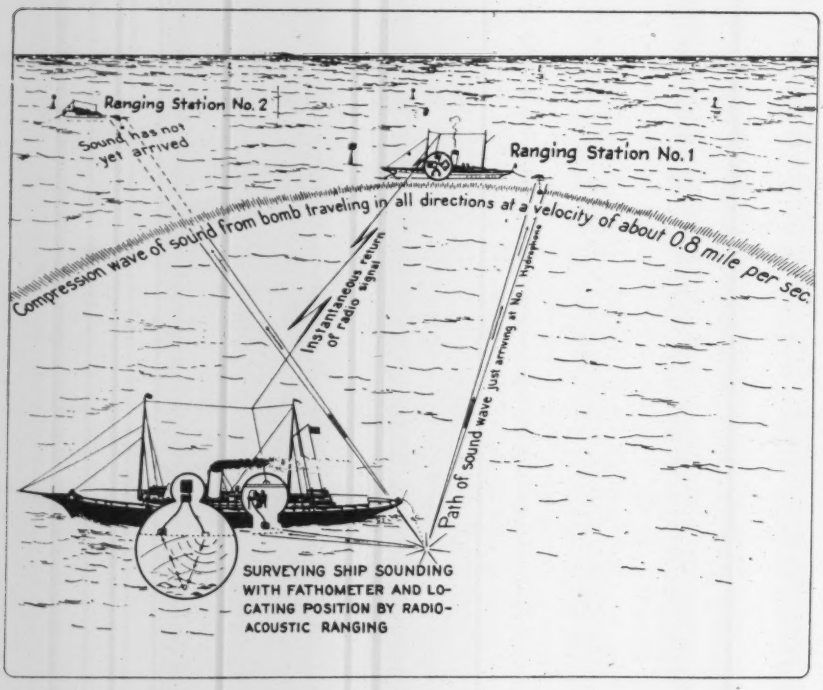

Ranging Station No. 2
Sound has not yet arrived
Ranging Station No. 1
Compression wave of sound from bomb traveling in all directions at a velocity of about 0.8 mile per sec.
Instantaneous return of radio signal
Path of sound wave just arriving at No. 1 Hydrophone
SURVEYING SHIP SOUNDING WITH FATHOMETER AND LOCATING POSITION BY RADIO-ACOUSTIC RANGING

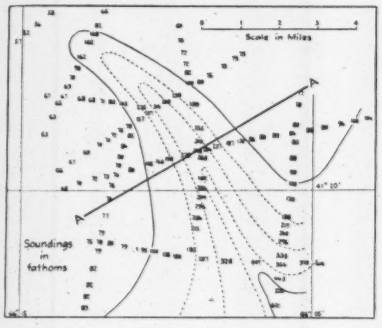
Fig. 5—Triangulation is conducted at sea by radio-acoustic ranging. Distances are computed from observations of the time of travel of a sound wave set up by the explosion of a small bomb. Depths are determined by echo sounding.

predictions, for there is scarcely any engineering operation that does not involve the measurement of elevations. These must be reckoned from some fixed level adopted as a reference plane or datum. While in some local engineering operations an arbitrary datum may be used, this practice is subject to serious objections. For example, operations based on different arbitrary datum planes cannot be related to each other. Furthermore, if the benchmark fixing such a plane is lost, the datum cannot be recovered. These disadvantages have led the engineer to adopt tidal-datum planes as references for elevations. They possess the advantages of definition, readiness of correlation and certainty of recovery should all benchmark connection be lost.

The basic datum plane that has been selected is that of mean sea level, and all civilized nations are now spreading lines of precise levels throughout the territories under their jurisdiction for the purpose of making this datum widely available. For furnishing the necessary starting points for the precise level net, the Coast and Geodetic Survey is securing tidal observations at a number of carefully selected places along the several coasts of the United States.

Theoretically, mean sea level is an equipotential surface; but the effects of wind and weather are such as to introduce deviations. These deviations are comparatively small, but precise leveling has brought out that mean sea level at San Francisco is 2 ft. higher than at St. Augustine, Fla., and that at the latter place it is 1½ ft. lower than at Portland, Me. The two ends of the Panama Canal are only about 30 miles apart,

Fig. 6—Chart of the submarine valley on Georges Bank, off the Massachusetts coast. By noting the time required to cross the valley, its speed and the maximum depth obtained by sounding, a vessel is able to tell whether it is on line *AA* or to the north or south of it and how far.



yet mean sea level on the Pacific side is about 0.7 ft. higher than on the Atlantic side.

If the rise and fall of the tide were exactly the same from day to day, the determination of the tidal datum planes would be a very simple matter. Any low water would determine mean low water, any high water would be mean high water, and any day of observations would determine mean sea level. But high water, low water and sea level vary from day to day, from month to month and from year to year. It has been found that the primary fluctuation of the tide goes through a cycle of about nineteen years. In other words, to determine accurately the tidal datum planes at any place requires nineteen years of observations. Fortunately, if series of this length exist at a number of places, datum planes for other places may be determined with considerable precision from observations covering a year of observations or even less. As a result the datum planes at hundreds of places along the coasts of the United States have now been determined and referred to benchmarks available to the engineer, the scientist and the public generally.

The benchmarks employed are usually of concrete and are set in rock where possible or in a mass of concrete. In other cases they are marked by bronze plates set in buildings or other substantial structures. A basic benchmark is made particularly substantial and is set in the vicinity where a long series of observations has been made. An additional precaution is the installation of a number of benchmarks so placed as not to be destroyed by the same contingencies. Hundreds of these benchmarks have been established at places along the coast of the United States, and their descriptions and elevations may be obtained on request from the Coast and Geodetic Survey.

Terrestrial magnetism

Engineers may be tempted to look at terrestrial magnetism merely as an instrumentality responsible for the inaccurate surveys made in the past with the surveyor's compass. Even though there is much justification for this viewpoint, the fact remains that every day in some parts of the United States magnetic compasses are used, especially in recovering old lines. Full knowledge of terrestrial magnetism, also, is obviously essential if mariners are to use the magnetic compass with full reliance that the magnetic courses taken from their charts are correct. Another recently developed use is the investigation of underground geological formations by magnetic methods, and many other stations of the bureau are used for this purpose. Aviation, too, owes much of its ability to deal with fog and darkness to the magnetic compass and in turn to the correct magnetic information on the maps prepared for its use.

In order that the Coast and Geodetic Survey can meet all these needs it is necessary to measure accurately, at five-year intervals, the magnetic elements at many points in the United States to keep track of the changes.

The problems of the earth's magnetism are somewhat similar to those of the tides, but the measurements must be more refined, and the phenomenon is far less amenable to mathematical treatment. Thirty years' experience shows that predictions must not be made for more than a few years ahead. There are never-ending changes in the earth's magnetism, and even in the rate of change, and sudden reversals have occurred. The problem of the Coast and Geodetic Survey is to measure the changes so that more than 5,000 observations in the United States and many more in the regions under its jurisdiction may be kept up to date.

The points where the observations are made must be so located as to give a representative value of the earth's magnetism, and especially they must undergo no change through the introduction of magnetic disturbance such as that due to the placing of iron or steel near the station whether above or below the ground, or by addition of direct-current electric circuits in the vicinity. Engineers who attempt to maintain marked points in cities and towns will realize that there is likelihood of disappearance of station mark or of azimuth mark or both and will understand why magnetic stations in cities and towns are being abandoned.

The solution has been to utilize the triangulation stations of the bureau for magnetic stations, since they are now placed at sufficiently frequent intervals and since they have suitable azimuth marks, established primarily for the local engineer.

But repeated observations at selected points will not alone suffice. Continuous observations at fixed observatories are also necessary. The Coast and Geodetic Survey operates five of these observatories from Puerto Rico to the Hawaiian Islands. The records are valuable not only for the purposes that have been described. They have proved indispensable in the important scientific effort to learn the nature of the earth's magnetism, and in the study of radio transmission and reception that has been found to be closely related to the earth's magnetism. This last is a striking example of a scientific use of records for purposes undreamed of when they were started.

Seismology

At first sight earthquakes seem somewhat remote from the making of charts. However, these earth phenomena have a close relation to the other work of the Coast and Geodetic Survey. In some cases earthquakes have been accompanied by important changes along the shore, as at Yakutat Bay, Alaska, in 1899. Geodetic methods are used to determine changes in position and heights of points in earthquake regions, to determine crustal creep and changes due to earthquake.

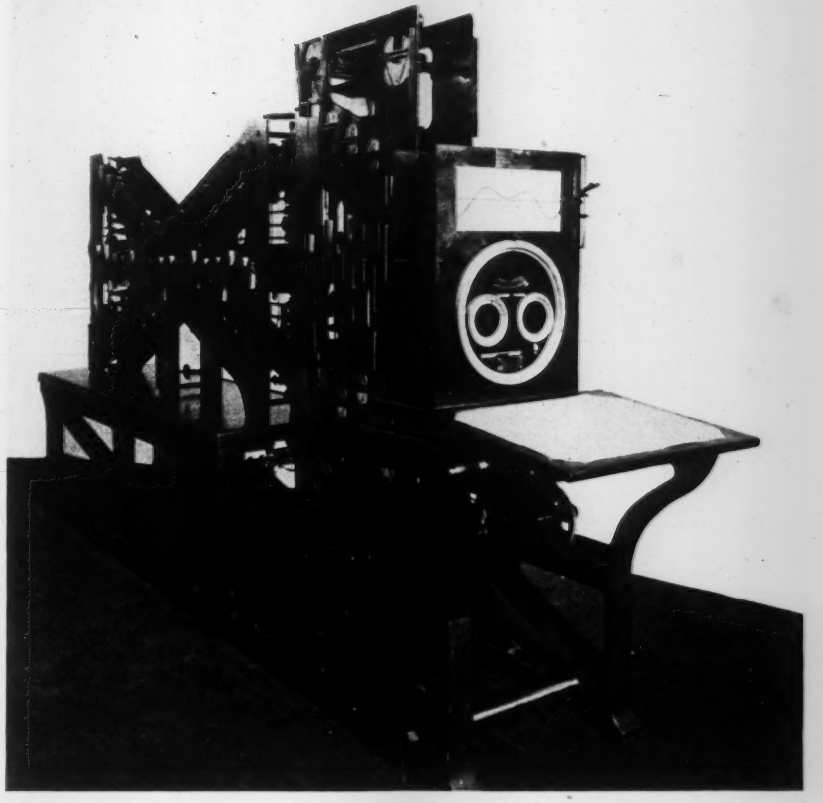


Fig. 7—The tide-predicting machine used by the Survey.

The operation of sensitive seismographs requires the same kind of attention as the magnetic instruments at observatories and, besides, the magnetic instruments give indications of earthquakes even if at a distance. For these reasons seismographs have been operated at some of the observatories for more than 30 years.

A recent development in the work is the installation in regions possibly subject to strong earthquakes of instruments capable of recording these motions. They fill an important gap, since they afford the promise that in future earthquakes the effects on buildings may be associated with the actual earth movements and the forces at work. These are fully described in *Engineering News-Record* for Sept. 8, 1932.

Everyone who has used a Coast and Geodetic Survey chart realizes that the activities that have been described are not sufficient to produce a complete chart. To accomplish fully its purpose of aiding the navigator, close cooperation must be maintained with other governmental agencies. The buoys, lightships, radio beacons and lighthouses, which aid the mariner so greatly in using the chart, are established and maintained by the Bureau of Lighthouses. Every harbor chart shows channels that were dredged under the direction of the Corps of Engineers. Many other examples could be given of close coordination of work of the Survey with that of other branches of the government. The Survey's problem is to set down at a given time the condition of a coastal region, and thereafter to carry out at suitable intervals the never-ending processes of bringing the information up to date.

* * *

To Carry Forward under normal conditions the activities described above, eleven survey ships are operating along the coastal waters of the Atlantic, Gulf and Pacific coasts, Philippine Islands, Hawaiian Islands, Puerto Rico and Alaska. These are supplemented by a number of large launches, some of which are attached to the ships as tenders, while others operate independently in the execution of inshore surveys. There are also field parties working in more than half the states of the Union as well as permanent and temporary stations at which observations are made with respect to earthquakes, terrestrial magnetism, gravity, tides and currents. In the office at Washington there is employed a trained group of scientists, mathematicians and chart makers. In all, there is a total force of more than 1,400 rendering practical services, the results of which are available to everyone. The annual expenditures for the last fiscal year amounted to $2,977,000.

The organization of the Bureau is as follows: director, Capt. R. S. Patton; assistant director, Comdr. J. H. Hawley; chief clerk, C. H. Dieck; chief, Division of Charts, Capt. E. H. Pagenhart; chief, Division of Geodesy, Capt. Wm. Bowie; chief, Division of Hydrography and Topography, Capt. G. T. Rude; chief, Division of Terrestrial Magnetism and Seismology, Capt. N. H. Heck; chief, Division of Tides and Currents, Capt. P. C. Whitney; chief, Division of Instruments, D. J. Parkhurst; chief, Division of Accounts, J. M. Griffin.

Arch Dam Built in Isolated Blocks To Reduce Shrinkage Effects

Efforts made to reduce shrinkage cracks to a minimum by permitting chemical heat to dissipate before filling slots between columnar blocks—Forked abutments result in saving of concrete

By F. A. Noetzli

Consulting Engineer, Los Angeles, Calif.

UNUSUAL INTEREST attaches to the method of construction used in the Grimsel dam in Switzerland because the construction method employed is not unlike that proposed for Hoover Dam. The central mass of the dam was built up in large columnar blocks and allowed to loose its heat of setting before the intervening slots were filled. During the first season only radial slots were left in the mass, but the development of axial-shrinkage cracks during the following winter indicated the need for, and resulted in the use of, axial slots during subsequent seasons. —EDITOR.

A HIGH ARCH DAM whose layout and construction involved several novel features was built recently in connection with a hydroelectric power development in the central part of the Swiss Alps. In the first place, the dam has "forked" abutments that made it possible to decrease the radius and span of the arch at the crest; and, second, in order to prevent cracks in the concrete due to shrinkage in an upstream and downstream direction, the dam is provided with longitudinal joints similar to those proposed for Hoover Dam.

The Grimsel dam is 373 ft. high above the deepest point of the foundation. It creates a reservoir of 82,000 acre-ft. capacity. The dam is located a few miles from the lower end of the Aar Glacier on the Grimsel Pass at an elevation of 6,200 ft. The water is utilized in two power plants, one under a head of 1,800 ft. and with an installed capacity of 120,000 hp., and one under a head of 2,200 ft. and with a capacity of 160,000 hp.

Grimsel dam is of the so-called constant-radius arch type. The radius of the upstream face at the crest is 295 f In cross-section the dam is triangula with an upstream slope of 0.10 and downstream slope of 0.50. The thickness of the dam is therefore 60 per cen of the height. This is not thick enoug for a gravity section but unusuall thick for an arch dam. The axial-arc stress by the cylinder formula is ap proximately 310 lb. per sq.in. Com bined cantilever and arch action as contemplated in the design.

The dam is located in a narrow canyon of practically symmetrical V-shaped cross-section whose walls ar of granite of massive formation wor smooth by glacial action. Condition for building an arch dam were, there fore, almost ideal.

Artificial abutments of the forked typ were provided for the upper arches o the dam. One fork of the abutmen is a buttress extending about in the directio n of the arch thrust. The other fork is a wing wall of gravity section providing the closure of the reservoir and preventing lateral water pressure upon the buttress. A gravity tangent would have had a very steeply sloping foundation area. The forked abutment permitted a shortening of the arch radius by about 10 per cent of the length otherwise necessary to reach the canyon walls at the crest. For the same axial-arch stress this resulted in a saving of practically 10 per cent of the concrete of the arch, whereas the forked abutments required only a relatively small yardage.

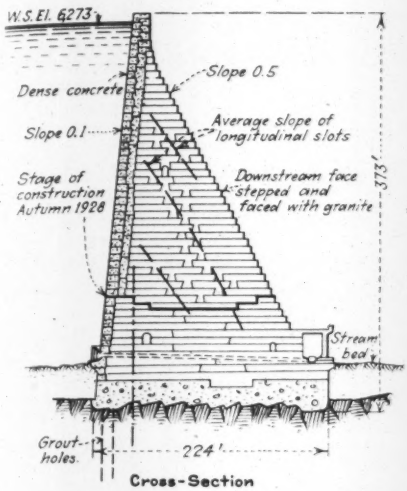
On account of the high altitude of 6,200 ft. above sea level and because of the correspondingly severe climatic conditions, special precautions were taken to protect the concrete of the dam against deterioration. Along the upstream face the concrete is of a specially rich mixture. The downstream face is stepped and is protected by granite ashlar masonry, behind which is located an elaborate drainage system for collection and disposal of water that may seep through the dam in spite of all precautions.

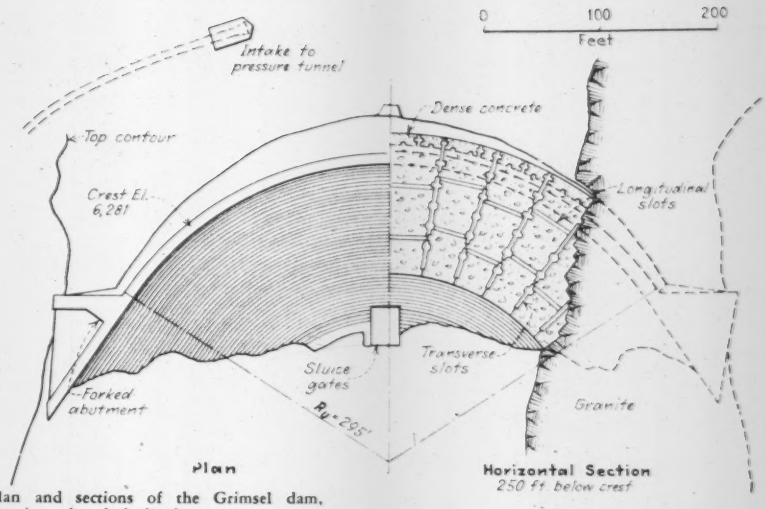
Grimsel dam is located in a narrow canyon in the Swiss Alps a few miles below the Aar Glacier. This picture was taken as the dam approached completion and the reservoir had begun to fill.

Construction features

The Grimsel dam was built of concrete deposited in part with chutes and in part by means of cableway buckets of 4.2-cu.yd. capacity. The work as such involved no unusual features, except that severe climatic conditions restricted the period of concreting to less than six months in any one year. Nevertheless, in one summer there was placed in the dam 175,000 cu.yd. of concrete in 142 days, with a maximum of 4,000 cu.yd. in one day and 60,000 cu.yd. in one month. The total volume of concrete in the dam is 445,000 cu.yd.

Placing of concrete was started in 1928. By the end of the season the dam had been built to a height of about 100 ft. Vertical radial slots were provided to allow for the contraction of the concrete. These slots were to be filled





Plan and sections of the Grimsel dam, showing the forked abutments, arrangement of slots and dense concrete at the upstream face of the dam.

with concrete at a time of low temperature and after the concrete of the adjoining vertical portions of the dam had lost its chemical heat. Numerous thermometers were set in the concrete to check temperature.

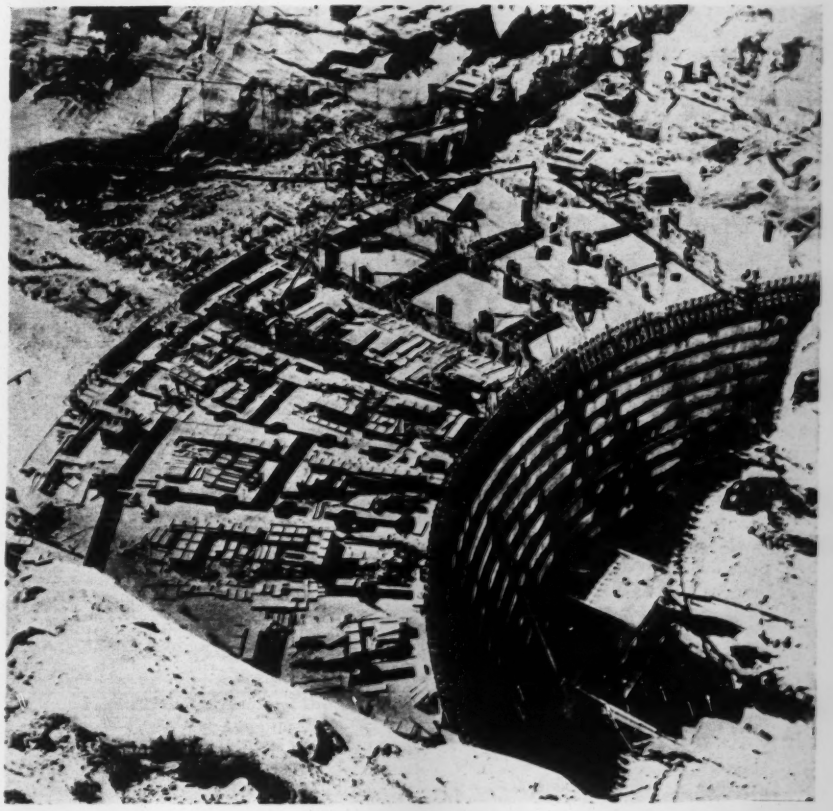
When, in the following spring, the snow that had covered the concrete to a depth of 10 to 15 ft. had melted away it was observed that the sections of the dam poured during the previous season had contracted not only between the radial slots but also in an upstream and downstream direction. This resulted in cracks approximately parallel to the axis of the dam. The cracks were spaced from 40 to 60 ft. apart and were up to ⅛ in. wide.

Concreting in columnar blocks

The structural effect of these longitudinal cracks was fully realized; also it was realized that they might extend into the upper part of the dam, either during the following winter or possibly later when the dam was being loaded. It was then decided to prevent an upward extension of the cracks by a very liberal amount of steel reinforcement in the first layers above the previous season's work, and to grout the cracks as well as practicable. In order to avoid the possibility of similar trouble in the upper portions of the dam, longitudinal slots were provided which, together with the previously arranged radial slots, divided the dam into upwardly extending sections of not more than a 50-ft. length and width. Key and groove connections were provided to take care of the vertical shear stresses. While the radial slots extended vertically in one plane for the full height of the dam, the longitudinal slots were carried up in zig-zag fashion with vertical legs of approximately 13 ft. each and horizontal offsets upstream or downstream of 5 to 10 ft. These longitudinal slots successfully prevented further cracking of the concrete. It was observed, nevertheless, that at least some of the joints opened up again, though by very small amounts. Inasmuch as shear keys were provided in all longitudinal joints the proper transmission of stresses across the joints seems assured. The longitudinal slots are arranged over the profile of the dam roughly in an upward and forward direction. In this direction the shear stresses are relatively small. Consequently, the longitudinal slots are not likely to affect materially the stability of the dam, even if some of the joints should have opened slightly after the dam was completed.

Similar cracking was observed in the Saint-Marc dam in France, as described by A. Renaud in *Annales des Ponts et Chaussées*, Mémoires et Documents No. 9, 1930. That dam is of the curved gravity type, about 150 ft. high and 120 ft. thick at the base. For purpose of repair the dam was reinforced and the cracks were grouted.

Both radial and axial slots were left in the dam until the chemical heat of the mass had dissipated. Subsequently they were filled with concrete.



Lake Zurich Breakwater Built on Piles

Concrete box girders, submerged below wave action and carried on capped cylinder piles, form breakwater for Wäldenswil Harbor on Lake Zurich, Switzerland

By A. J. Luchinger
Construction Engineer, Locher Cie., Zurich, Switzerland

A BREAKWATER of notable design and construction was built last winter on Lake Zurich in Switzerland. The structure is 361 ft. long and creates an artificial harbor for the town of Wäldenswil.

On the line of the breakwater the lake is about 45 ft. deep, but the foundation had to be carried down to gravel 80 to 100 ft. below lake level. Overlaying the gravel is a soft silt, which has no bearing value. These conditions called for a breakwater wall on pile foundations.

To reduce the weight of the wall as much as possible, it was decided to extend it only so far below the lowest lake level that the waves outside the barrier would have no agitating effect on the interior of the harbor. This depth was established by a model test in the hydraulic laboratory of the Swiss Technical University in Zurich. The maximum wave height of the lake is 3.3 ft., and the wave length is 40 ft. It was found that for these conditions a depth of wall of 8 ft. below water level would fully protect the inside of the harbor. The wall at low water is 6 ft. above water level; the total height is therefore 14 ft., and the width is 12½ ft.

The superstructure consists of four hollow reinforced-concrete caissons 82 ft. long, which are supported at their ends by piers. A short reinforced-concrete span connects the main structure to the shore. The piers are groups of eight piles 2 ft. 4 in. in diameter and a maximum of 90 ft. in length. The piles are steel cylinders, with ⅜-in. shells, filled with concrete. The tops of the piles of each pier are capped below water by a reinforced-concrete slab (Fig. 1).

The force of a wave 3.3 ft. high and 40 ft. long acting on the proposed structure was determined by model test to be 0.7 tons per linear foot of the wall. As the main waves act in a direction 45 deg. to the wall, the force used in design was reduced to 0.35 tons per linear foot. To reduce the bending moment in the piles, the outside piles are given a batter of 2 in. in 1 ft. The maximum load carried by one pile amounts to 90 tons.

The reinforced-concrete caissons of the superstructure were built on a pile scaffolding on the shore of the lake near the future breakwater. The floor on which the caissons were built was suspended on the scaffolding by screws. After removing the side and deck forms the caisson was lowered on this hanging floor into the water until it began to float and could be towed away. The floor was then screwed up out of the water and used as support for the next caisson. The first finished caissons were used temporarily as pontoons for the floating piledriver equipment (Fig. 2).

The steel cylinders for the piles were furnished in full lengths to the job. They were closed watertight at both ends and floated to the pier positions. They were hoisted up at one end, the temporary covers were removed, and an electrically driven piledriver drove them

Fig 2—Reinforced-concrete caissons for the superstructure. In the background is one caisson suspended on scaffolding; at left, one caisson floating; at right, two caissons used as pontoons for the piledriving equipment.

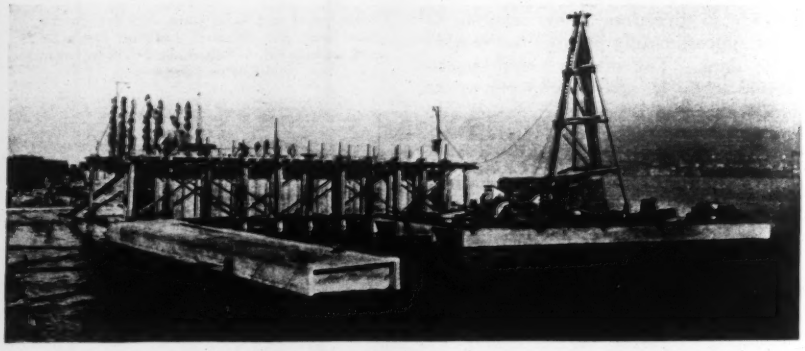
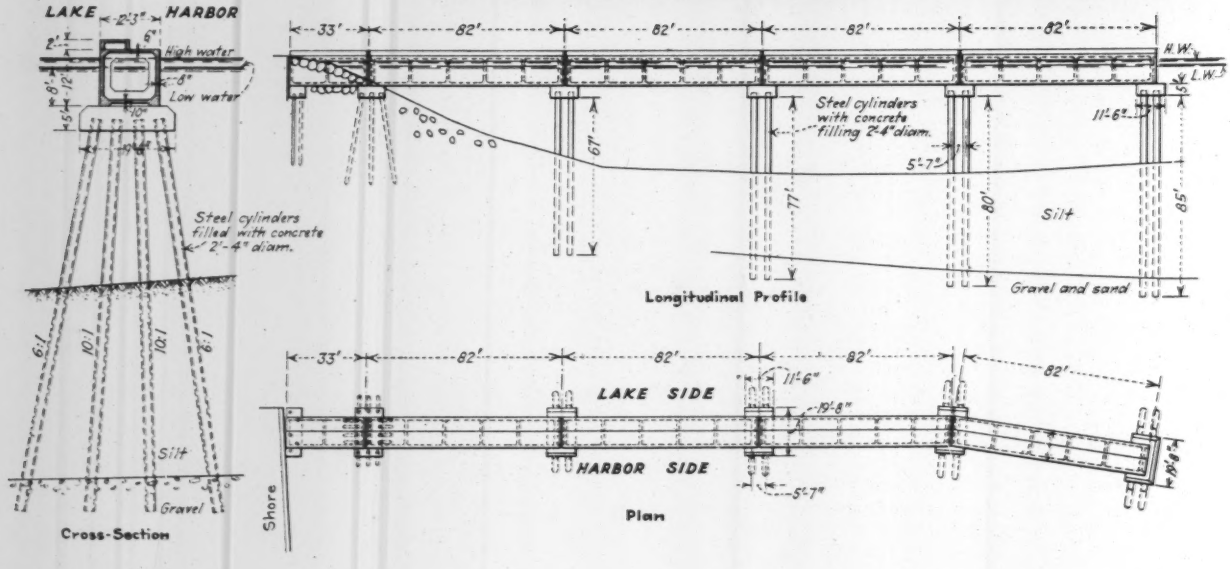


Fig. 1—Profile, plan and cross-section of breakwater on pile foundations at Wäldenswil in Switzerland.



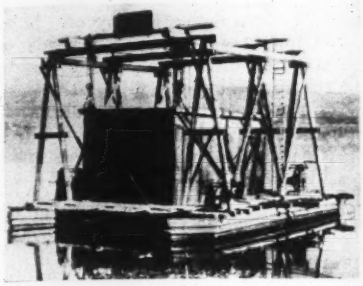


Fig. 3—Timber cofferdam for constructing cap on cylinder piles.

down through the silt into the gravel.

The silt in the cylinders was dredged out by a compressed-air ejector; occasional boulders were removed by an orange-peel bucket. The cylinders were then filled for two-thirds of their height with concrete under water with a small concrete bucket. The driving, dredging and concreting of one pile took about three days.

The most difficult work was the construction of the reinforced-concrete cap that connects the cylinders about 14 ft. below water level. For this purpose a heavy timber crib without bottom, about 16 ft. high and as long and wide as the slab, was lowered over the piles (Fig. 3). The top of the crib extended above water level, and the lower end to about 3 ft. below the tops of the piles. At this elevation the diver fastened a timber bottom between the piles and the side walls of the crib, upon which a bottom seal of concrete 2 ft. thick was poured under water within the crib between the protruding piles. After this concrete had set, the crib was pumped out. This upper third of the cylinders and the upper part of the slab over the piles were then reinforced with steel and concreted in the dry. Lead plates were set on top as bearings for the superstructure.

After the piers had been built, the caissons were launched to position. By pumping in water they were set down on the prepared bearings. Holes were then drilled in the bottom slabs of the caissons in order to keep the water level inside the same as outside, so the caissons cannot float up at high-water stages.

The work was done under the direction of the Swiss Federal Railways. The design and construction were awarded to the firm of Locher Cie., Zurich, and were carried out according to their proposal.

Building Sewers in Winter With City Welfare Labor

SEWER construction amounting to $300,000 was carried on last winter in Duluth largely for the purpose of aiding the unemployed. Close records of cost were kept. Both the day-labor and contract methods were used, about half and half, the contract work costing about 25 per cent less than that done by the day-labor method. Special-assessment work was awarded in the usual manner, otherwise the validity of the proceedings might have been attacked. Where work was being financed by bond issue, the contract provided that all common labor should be secured through the city unemployment committee, in accordance with such rules and regulations as the committee might formulate from time to time. This system was not entirely satisfactory largely because there was no one on the unemployment committee with any practical experience in conducting public work. The result was that, for the greater portion of the time, neither the engineers in charge of the work nor the contractor carrying it on knew what rules they were working under. Naturally there was considerable suspicion that some contractors were being favored at the expense of the unemployed.

The principal advantage of the system was that contractors owning rock drills, air compressors, etc., were willing to supply this equipment at little or no return in order to keep their organizations employed. Accordingly, the cost of the work was little more than it would have been had the work been done in the summer time. Duluth has a minimum-wage ordinance, and all contractors were obliged to pay 50c. per hour for common labor.

For a time a man would be allowed to work six days or 48 hours, at which time he would be replaced by someone else on the waiting list. Later this was changed to three days or twenty-four hours, in order to reduce the long waiting list and give more men a chance.

This same system of rotation was used on day-work projects so that all sorts and conditions of men were employed. On one occasion a man showed up for work driving a Pierce-Arrow car. Another man who had performed nothing but clerical work all his life reported in a pair of tan oxford shoes, maybe the only pair he had, to go down in a muddy ditch. Another man, working a few hours, hit himself on the head with a pick, which he had never used before, and was thus entitled to a week's compensation, in accordance with the employers' liability laws. Another picked up a rock with the intention of throwing it over the waste pile, but dropped it on the head of a man working below, resulting in another hospital case.

Some of the most difficult work was carried on by day labor where the frost was 5 ft. deep and where there were 4 or 5 ft. of the hardest gabbro in the bottom of a 14-ft. trench. The frozen earth was broken by air compressors, and the rock was drilled with air equipment, all of which had to be rented.

Various members of the city engineer's staff served as foremen, and a larger percentage of unskilled unemployed were used than by the contractors. The contractors' skilled labor, such as powder men, pipe layers, jackhammer men, carpenters, etc., were doing the work of common laborers much of the time. The contractors were also accused of using some of these old timers as pace setters for the unemployed, and thus exhausting the less rugged before their allotted time was up.

Because of the variable nature of the work it is difficult to make comparisons between the two methods. In general, day labor cost about 25 per cent more than contract work, but the rental of equipment had something to do with this. The segregation of the day-labor costs, covering 54 jobs, is as shown in the following tabulation:

	Cost	Per Cent of Total
Picks, shovels and other small tools	$1,010.97	0.6
Materials, sewer pipe, etc.	51,967.75	31.46
Rental of air compressors and drills	11,868.32	7.2
Rental of trucks	10,736.89	6.5
Teams	3,161.07	1.9
Steam shovel	500.00	0.3
Dynamite and caps	503.91	0.3
Workmen's compensation	286.75	0.2
Doctors' fees	431.75	0.26
Damages	75.00	0.05
Transportation	44.54	0.03
Changing grade of water and gas lines	649.04	0.4
Labor	82,936.75	50.2
Miscellaneous	941.51	0.6
Total	$165,114.25	100.00

Considerable work was done with teams and wheelers that could have been done at less cost by steam shovel and trucks. Teams were used, as the owners in some cases were unable to buy horse feed. Such items as air compressors, trucks and teams include a certain amount of labor, as the wages of the truck drivers, jackhammer men and teamsters were included in the rent paid for the equipment. The total amount paid directly to labor probably amounted to 55 per cent. The greater portion of the pipe used was manufactured in a local plant. The cement used was also a Duluth product, a further item to the credit of employment.

The work was carried out under the general direction of John Wilson, city engineer, who states that taken as a whole the plan worked quite satisfactorily and probably was a better method of helping the unemployed than administering direct relief.

Centralized Road Control in North Carolina

The record of a year's experience by the first state to take over the administration of all public roads

THE RESPONSIBILITY for all county and township roads in North Carolina, nearly 46,000 miles, was turned over to the state highway commission on July 1, 1931. This action of the state legislature resulted mainly from a state-wide demand that the road-tax burden should be shifted from personal property and real estate to motor vehicles, by way of license and gasoline taxes levied by the state. The change was made complete; no governmental unit other than the state was allowed to levy a tax for road purposes except previous road-debt service and payment.

To obtain the necessary additional state funds, 1c. was added to the gasoline tax rate, making it 6c. Certain allotments from state highway funds previously made to the counties were also set aside for local roads. The law also required that at least $6,000,000 annually should be spent on these roads.

Generally speaking, three distinct areas of widely different physical, industrial and agricultural characteristics exist in North Carolina. This diversity calls for various methods of local road construction and maintenance.

Extending inland from the Atlantic coast for 100 to 150 miles is a flat, sandy coastal plain, with large areas of swamps. Satisfactory materials for local road surfacing are largely lacking. With few exceptions, the population is scant, and there is a limited number of towns and small cities.

West of the coastal plain, with a width of 125 to 175 miles, is the most highly developed and most populous section of the state known as the Piedmont. Over most of this area are clay soils with ample local deposits of sand, top soil or gravel suitable for surfacing highways carrying light traffic. Agriculture reaches its highest development in this section of the state. Here also are numerous towns and small cities with many industries that depend increasingly on highway transportation.

The remaining western part of the state rises gradually to the high mountains that make up most of that section. Heavy rock excavation is common, with creek gravel or stone that can be used for surfacing purely local roads available in most places. Heavy rainfall and steep slopes complicate highway maintenance. On the other hand, population is scant, and there are few towns and small cities, most of which are on the original state highway system.

Only 913 miles of hard-surfaced highways were included in the 45,338 taken over on July 1, 1931, from the counties by the state. This classification also included all roads surfaced in any way better than top soil, sand, clay or gravel. Very little of the mileage of hard-surfaced local roads was up to state standards. Out of the 913 miles 38 miles were transferred from the local road system to the basic state system during the first fiscal year.

In the beginning there were 10,217 miles of local roads that the state classed as top-soil types. These included various sorts of local surfacing materials. They were in all conditions, with a small percentage of the total mileage really up to good standards.

On July 1, 1931, the state listed 18,508 miles of the local roads as graded. It was evident then and has become increasingly so since that most of this large mileage will have to be practically rebuilt to bring it to year-round useful condition.

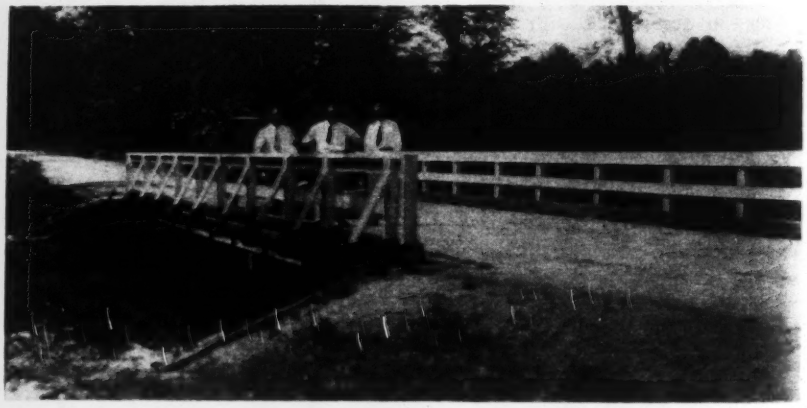
There remained from the total local road mileage some 15,700 miles that were put down as unimproved. A large part of the roads of this class were in the sparsely settled eastern and western sections of the state. A good many of the unimproved roads were more or less impassable for motor vehicles during a part of the year. In fact, some of them hardly would be considered roads. In this connection, it is significant that nearly 300 miles of such roads listed by the counties were removed from the map the first year. About 2,590 miles of unimproved roads was mileage of which county authorities had no record, or had given them no attention in their budgets or operations.

Generally speaking, nearly all the 45,338 miles of local roads were in poor condition when they were taken over by the state. The idea of centralization of highway control had been before the legislature for some months previously. Most of the county authorities realized after the end of that winter and before the usual heavy spring work would ordinarily start that the change in control was certain. They simply kept such maintenance work going as was absolutely necessary and let the rest slide. The state thus arrived on the job with an immense amount of deferred maintenance, in addition to the work regularly needed. The season also was half gone before the state forces were given control. Hence the first year's problems were much aggravated.

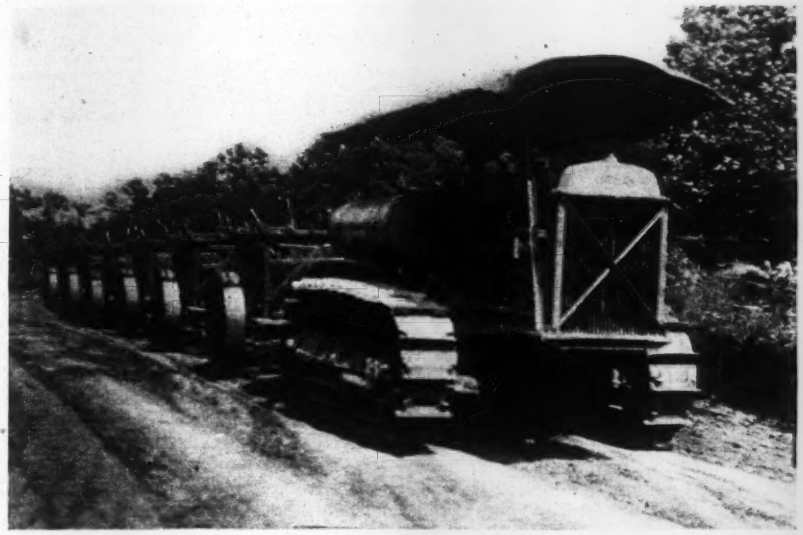
No. 2—One-man motor graders employed in large numbers to shape up subgrade for surfacing. These machines also play a large part in maintaining local roads.

Equipment taken over

Two months before the state took over the highway equipment and plant of the several counties an inventory of such property was made. The results of this inventory are shown in an accompanying table. On July 1, 1931, the serviceable plant and equipment were taken over by the state on the basis



No. 1—Type of creosoted pile and timber structure used extensively on local roads to replace inadequate bridges. Most of these structures are built out of maintenance funds.



No. 3—Train of excavating dump wagons handled by large crawler tractor engaged in moving top soil from adjacent borrow-pits to surface local roads. For hauls up to 1,000 ft. these outfits have proved quite effective.

stated in the same table. The low percentages of some classes of equipment accepted by the state was due partly to the rest being obsolete. In a surprising number of cases, however, the equipment had practically been ruined by lack of attention. In fact, nearly all heavy equipment accepted had to have major repairs before it could be put in service. Even after receiving such major repairs, much of the former county equipment was of limited value. This poor condition was due to a considerable extent to the fact that the local auhorities realized that the state would soon be responsible for the whole road situation and deferred shop work just as long as the machines would continue to run.

Organizing for the work

Under the old plan of local road construction and maintenance by the counties the type and extent of the county highway organizations varied greatly. In a few of the wealthier and more populous counties work was under the direction of an engineer or superintendent on a full-time basis. About a dozen of these counties had their local roads in good shape. To do this, they maintained full-time organizations and employed considerable equipment.

In all the remaining counties the highways were supervised by local men of limited ability and experienec. Few of these counties had any equipment other than road machines. Some which did have considerable equipment had selected outfits poorly suited to their needs.

When the state highway commission took over the local roads, it simply revamped and expanded its existing engineering and supervising organization. Five divisions were established, each containing an average of twenty counties, with five districts in each division. Each division is headed by an engineer who has an assistant engineer in each district. Most of the engineers previously in charge of county highway work were taken into the state organization and given a larger territory.

Local maintenance crews, or section men, under the previous state organization plan had their mileage increased from 30 to 40 per cent to include part of the local roads. Section men were added to handle the local roads not thus absorbed by the existing forces.

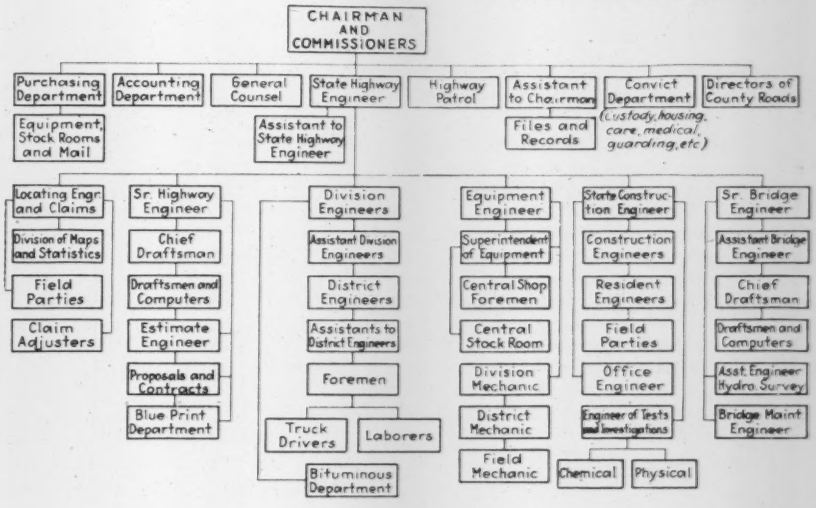
Local conditions and the volume and character of local traffic vary so greatly in different sections of the state that no exact standard mileage for a section crew has been established. The range is from 30 to 42 miles for a crew of two or three men on the original state highway system and from 75 to 110 miles on county roads.

The policy of the state highway commission during the first year it handled the local roads was to get the maximum possible number of people out of the mud twelve months in the year. This manifestly was impracticable over the entire 46,000 miles taken over by the state. Nor will it probably ever be good business to do much more than drain and drag most of the local road mileage. On the remainder, embracing the roads that carry the bulk of local traffic, it has been possible with the limited funds available largely to regrade, and to surface to a limited extent.

In regrading and surfacing these more important local roads the division engineers and their district assistants handle the job with practically no advance detail engineering and designing. Local materials that would not be suitable for surfacing heavy traffic highways have proved sufficient for the local roads. Where sand or gravel is used on clay soils, just enough is added to stabilize the base. When placing broken stone on local roads, portable crushing outfits reduce whatever rock is available. By using only 2 or 3 in. of these local materials, a surface that carries the limited local traffic is obtained at a very low cost per mile, provided the base is properly drained and graded.

Machinery and equipment have presented one of the most serious problems that had to be solved in taking over the 46,000 miles of local roads. Under the act requiring the change the counties had to turn their road machinery and equipment over to the state. A general inventory indicated that the county outfits would to a considerable extent meet the needs of the expanded highway responsibilities of the state. When these outfits were brought into state highway shops for close inspection and overhauling, it was found that poor upkeep had ruined practically much of it. Hence the state had to purchase nearly $600,000 worth more of machinery and equipment than reasonably would have been expected.

No. 4—Organization diagram of North Carolina State Highway Commission.



Wherever extensive grading has to be done on the principal local highways, large tractors pulling heavy road machines are used almost entirely. These outfits ditch and shape up the local roads at a surprisingly low cost per mile. With them it is possible in most cases to shape the road base so that surfacing materials may be applied without further blading. By shifting these large outfits from place to place their use is highly justified under the centralized state control, while few counties in the state really could afford to own even a single outfit of this type. The former officials in most of these counties also had no idea of how to use such outfits properly.

On most of the local-road maintenance sections the crew is provided with a dump-body truck heavy enough to pull a road drag. Most of the crews also have a light crawler tractor and a blade machine. The general policy is to provide enough equipment so that a crew can shape up and drag its entire mileage within three or four days following a rainy period.

TYPES OF COUNTY ROAD EQUIPMENT AND PERCENTAGE FOUND AVAILABLE AND TAKEN OVER BY THE STATE

	County Equipment as Inventory, May, 1931	Inventory of County Equipment Taken Over, July 1, 1931	Percentage of May Inventory Accepted as Usable and Given an Appraised Value July 1, 1931
Cars	89	47	53
Trucks, 1 to 2 tons	543	393	73
Trucks, 2½ tons and over	437	283	65
Tractors, wheel type	162	115	71
Tractors, crawler, 35 hp. and under	351	290	83
Tractors, crawler, 40 hp. and over	92	71	77
Road machines	811	644	100
Shovels, power	6	6	100
Motor graders	23	23	100
Crushers, stationary	9	9	100
Crushers, portable	27	27	100
Wheelers	524	524	100
Wagons	233	233	100

No. 5—A 16-ft. clear-span bridge built with material secured from the right-of-way.

Part of the act providing for state handling of local roads required the state highway commission to maintain and use on the roads all county prisoners sentenced for 60 days or more. In order to house and handle a total of 4,000 to 5,000 prisoners, the state had to build 30 prison camps. These are located at strategic points throughout the state. The custody, housing and responsibility for the convicts rests with the executives of the state highway commission. The engineering department merely handles the prisoners as so many laborers, transporting them daily from the camps to the point where they are used and back again at night.

Recognizing that convict labor always has been unsatisfactory on road work, the state highway commission made special efforts to increase the efficiency of the large number of prisoners it is forced to use. Exceptionally good camps have been provided. The men are well fed and reasonably treated. Experience has shown that, under existing conditions, convicts have been doing almost as good work as hired labor. While this is doubtless due largely to the manner in which the men are housed and handled, it appears that lack of jobs if the men were free has a large bearing on their willingness to do a full day's work.

Convicts are used only on jobs where a number of them can be kept together to reduce the cost of guarding. This eliminates them from routine maintenance work. Consequently they are employed as extra gangs in building bridges, clearing, ditching and quarry operations.

One factor that was specially serious on most of the county roads was the lack of proper ditching and adequate waterways. With the limited funds available, it is necessary to use local material for small bridges over waterways just as far as possible. Careful selection of timber cut near by and liberal use of creosote for treating such timber has resulted in the provision of satisfactory small bridges on these local roads at surprisingly nominal expense.

In all of this local road work the distribution of funds had to be made on an arbitrary basis, since there was no precedent to follow. The money was therefore allotted to the several divisions on the basis of area, population, road mileage and motor-vehicle registration. The districts within each division in turn set up a tentative budget on the same basis. In practice, primary consideration were given to roads carrying school buses, mail routes and unusually heavy traffic. Other roads received attention as the money was available and as traffic and other conditions made improvements necessary.

In the face of these conditions, from a standing start, the state forces caught up with the deferred maintenance in a few months. At the same time, during the first fiscal year 5,038 miles of the local roads were surfaced with top soil, gravel or other local materials. It also was found desirable to transfer 1,245 miles of the former county roads that had been classed as top-soil types to the basic state system.

During this period there also were about 4,000 miles of unimproved roads graded to good standards. At the end of June, 1932, there thus remained only 10,826 miles of unimproved roads. A considerable part of this unimproved mileage serves such limited traffic that there is little justification for much work on it. The policy is to handle each of the roads according to local conditions.

During the twelve months ending with last June the state actually spent on local roads $6,173,000. With this expenditure, local roads over the state as a whole are in far better condition than they ever were under the former independent county-highway-organization plan. Indeed the state practically rebuilt upwards of 5,035 miles of the principal local roads during the first twelve months it had charge of the roads. Nearly all this has been done as maintenance work, since there have been only a few projects designated as construction.

Equipment purchases the first year involved $880,000, of which $440,000 was charged to operations and is included in the total expenditures for the first twelve months. The other half will be charged to subsequent operations. Centralized control thus has given much better local roads for considerably less money than the counties previously were spending ($8,000,000) on them. It also has done this in a year when a lack of funds would have forced many counties to reduce or to stop entirely all road work.

Highway Location Problem Solved by Tunnel

Bore of 1,085 ft. saves distance of 4 miles on connecting link between main Pacific Coast highways in Oregon

By E. A. Collier
Division Engineer, Oregon State Highway Commission. Salem, Ore.

A HIGHWAY tunnel proved an economic feature in the construction by the Oregon state highway commission of the Umpqua Highway to serve as a connecting link between the two major Pacific Coast highways. The link is 50 miles long, extending from Drain, Ore., on the Pacific Highway to Reedsport on the Coast Highway, at the mouth of the Umpqua River. About 10 miles from the east end the line approaches Elk Creek at a point where it flows around the end of a long narrow ridge. The location following the creek around this bend is 5½ miles long, and the climb over the ridge would have necessitated about 3 miles of grade. These distances compare with a length of 1.6 miles for the tunnel alignment between the two common points on the highway location. Advantages of the tunnel route were readily apparent. The location necessitated two bridges located near the portals.

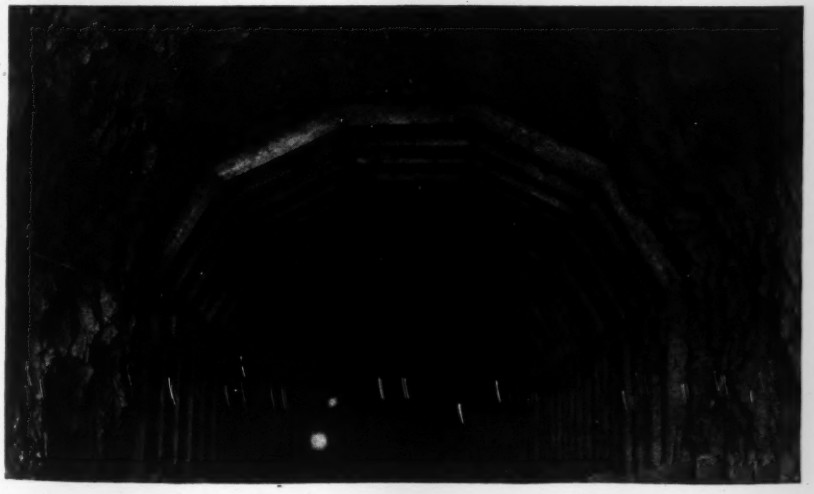
Three miles of grade over a ridge was eliminated by this 1,085-ft. tunnel in Oregon.

The tunnel is 1,085 ft. long on a 2½-deg. curve with a grade of 1 per cent. The roadway is a 24-ft. concrete paving between curbs with a 1-ft. superelevation. Height to roof is 21 ft., with a three-center arch of 15-ft. center radius flanked by short arcs of 6-ft. radius on either side. The width of the tunnel is 26 ft., and the spring line is 12 ft. above profile grade.

Lining is provided for 511 ft., consisting of 10x14-in. plumb posts and a five-segment ring of the same size timber. A 4-in. thickness of lagging is used for the arch with the voids packed solid with cord wood. All the timber used was Port Orford cedar, which has a splendid record for long life. The posts were set on concrete sills, which also served as curbs when the paving was placed.

Driving was done with an 8x9-ft. center heading enlarged by ring-drilling to final tunnel size. Two eight-hour shifts were worked at each end of the tunnel, and the headings met 80 days after work started at the portals. Air was supplied from a 580-ft. diesel-driven compressor located on the ridge over the tunnel. For driving the center heading the round usually consisted of eighteen to twenty holes 6 ft. deep, pulling about 4 ft. of rock. Ring-drilling was at 4-ft. spacing and included about 32 holes per ring. These rings were loaded and fired in pairs.

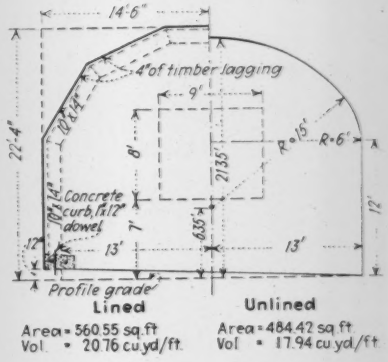
Section showing characteristics of the lined and unlined lengths of the tunnel.



Excavation for the enlargement was done with a 1-yd. power shovel with shortened boom and dipper stick, loading into trucks. Although the center heading provided some ventilation and blowers were used, considerable trouble was experienced with the gas from the shovel and trucks. Average progress for the shovel was 7 ft. per shift.

The pioneer heading exposed a stratified sandstone with occasional strata of shale. No trouble was experienced with the sandstone, and no lining was used. The shale provided the driving problem and necessitated lining, particularly at two fault locations. By plotting the location of the shale and projecting it to the intersection of the finished tunnel limit an estimate was made of the sections that would require timber lining, and excavation was enlarged accordingly. It was necessary to support the shale with temporary timbering, the action of air causing slacking. Considerable falls of rock occurred at several places. However, the contractors completed the job without a fatality.

Beginning of lined section required by weathering shale. Timber lining and cordwood packing is of Port Orford cedar.



Ventilation appears to be good in the tunnel since its completion. No plans have been made for lighting, although in the future lights may be installed, as the length and curvature prevent sufficient illumination from the portals. The need for lighting is particularly noticeable in the daytime.

Unit prices included $3.10 per yd. for tunnel excavation and $60 per M for the cedar lining timber in place. The tunnel cost was $51.35 per foot for unlined section and $100.36 per foot for lined section. Contract for the tunnel was held by Wrenn & Greenough, Portland. The work was carried out by the Oregon state highway commission under the general supervision of R. A. Klein, state highway engineer who was succeeded by R. H. Baldock before the work was completed. The writer was in charge of the work as division engineer.

Modern Practices in Bridge Re-Decking

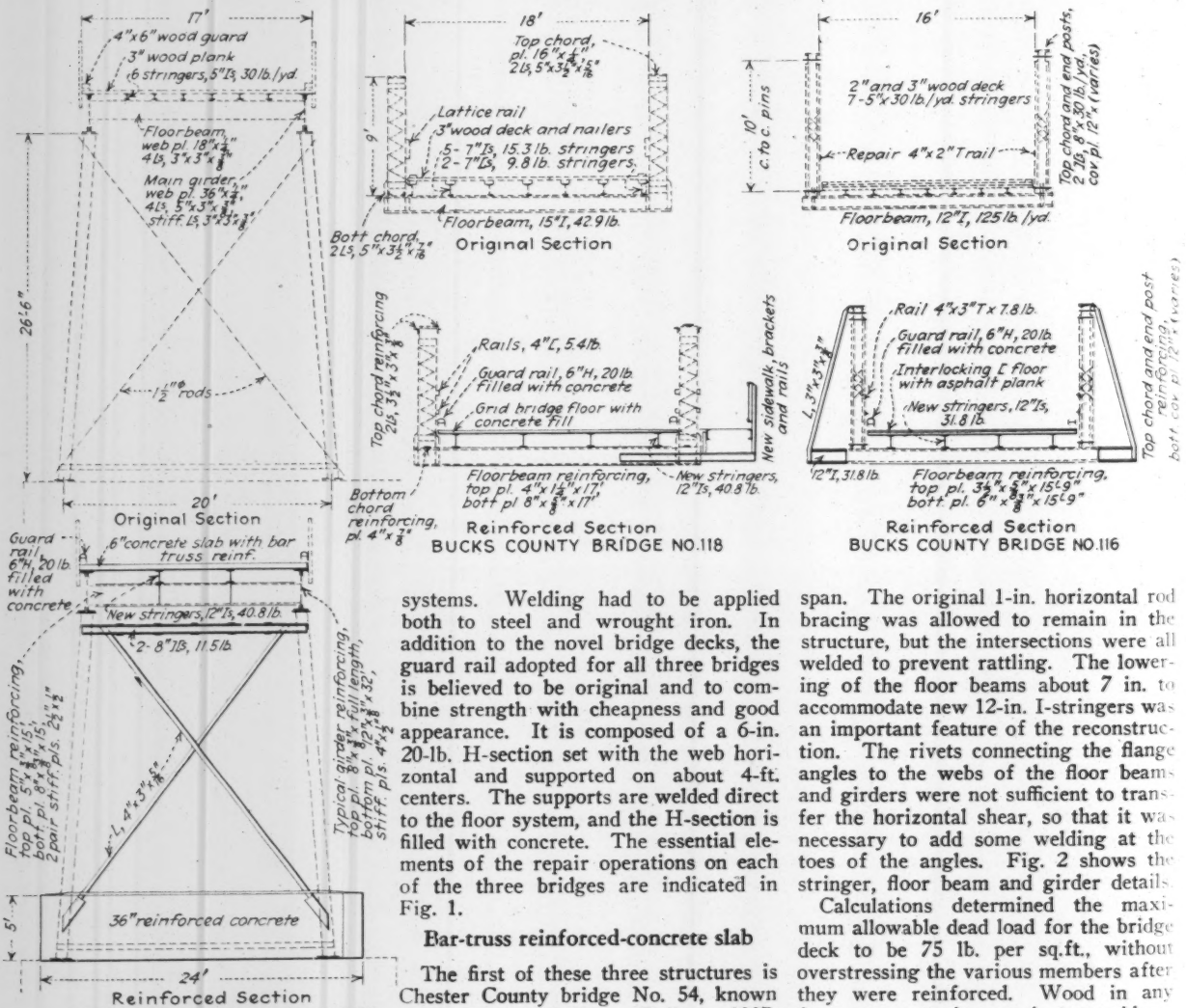
Light concrete slab and special design steel floors combined with arc-welding used to repair and reinforce several county bridges in Pennsylvania—Experience in welding wrought iron

By William F. Carson
Carson & Carson, Consulting Engineers, Philadelphia, Pa.

MANY of the early steel and wrought-iron highway bridges have outlived their usefulness, are too light, too narrow or have so deteriorated that they should be scrapped and replaced with modern structures. On the other hand, there are still thousands of these old bridges which can, and some of them are, being repaired and strengthened at small cost so that they will be adequate for many years. Three examples of such repair work are afforded by recent work in two Pennsylvania counties.

All three bridges were originally decked with wood plank, and the reconstructions involved three different types of modern bridge floors. Electric arc-welding played an important part not only in the reinforcing but also in connection with the new permanent floor systems. Welding had to be applied both to steel and wrought iron. In addition to the novel bridge decks, the guard rail adopted for all three bridges is believed to be original and to combine strength with cheapness and good appearance. It is composed of a 6-in. 20-lb. H-section set with the web horizontal and supported on about 4-ft. centers. The supports are welded direct to the floor system, and the H-section is filled with concrete. The essential elements of the repair operations on each of the three bridges are indicated in Fig. 1.

Fig. 1—Typical sections of old county highway bridges in Pennsylvania before and after reinforcing and adding new floors.


17'
4"x6" wood guard
3" wood plank
6 stringers, 5" I's, 30 lb./yd.
Floorbeam, web pl. 18"x1/4", 4 L's, 3"x3"x1/2"
Main girder, web pl. 36"x1/4", 4 L's, 5"x3"x1/2", stiff. L's, 3"x2 1/2"x3/8"
26'-6"
1 1/2" ø rods
20'
Original Section
Guard rail 6"H, 20 lb. filled with concrete
6" concrete slab with bar truss reinf.
New stringers, 12" I's, 40.8 lb.
2-8" I's, 11.5 lb.
Floorbeam reinforcing, top pl. 5"x1/2"x15', bott. pl. 8"x1/2"x15', 2 pair stiff. pls. 2 1/2"x1/2"
L, 4"x3"x5/16"
Typical girder reinforcing, top pl. 8"x1/2"x full length, bottom pl. 12"x1/2"x32', stiff. p's. 4"x1/2"
5'
36" reinforced concrete
24'
Reinforced Section
CHESTER COUNTY BRIDGE NO. 54
18'
Top chord, pl. 16"x1/2", 2 L's, 5"x3 1/2"x7/16"
9'
Lattice rail
3" wood deck and nailers
5-7" I's, 15.3 lb. stringers
2-7" I's, 9.8 lb. stringers
Floorbeam, 15" I, 42.9 lb.
Bott. chord, 2 L's, 5"x3 1/2"x7/16"
Original Section
Top chord reinforcing, 2 L's, 3 1/2"x3"x3/8"
Rails, 4" I, 5.4 lb.
Guard rail, 6"H, 20 lb. filled with concrete
Grid bridge floor with concrete fill
New sidewalk brackets and rails
Floorbeam reinforcing, top pl. 4"x1/2"x17', bott pl 8"x5/8"x17'
New stringers, 12" I's, 40.8 lb.
Bottom chord reinforcing, pl. 4"x3/8"
Reinforced Section
BUCKS COUNTY BRIDGE NO. 118
16'
10' c. to c. pins
2" and 3" wood deck
7-5"x30 lb./yd. stringers
Repair 4"x2" T rail
Top chord and end posts, 2 L's, 8"x30 lb./yd., cov pl. 12"x (varies)
Floorbeam, 12" I, 125 lb./yd.
Original Section
Rail 4"x3" T x 7.8 lb.
Guard rail, 6"H, 20 lb. filled with concrete
Interlocking L floor with asphalt plank
L, 3"x3"x5/16"
New stringers, 12" I's, 31.8 lb.
12" I, 31.8 lb.
Floorbeam reinforcing, top pl. 3 1/2"x5/8"x15'-9", bott pl. 6"x5/8"x15'-9"
Top chord and end post reinforcing, bott. cov. pl. 12"x (varies)
Reinforced Section
BUCKS COUNTY BRIDGE NO. 116

Bar-truss reinforced-concrete slab

The first of these three structures is Chester County bridge No. 54, known as the Laurel Bridge. Built in 1887, this wrought-iron viaduct crosses the valley of the East Branch of White Clay Creek about 8 miles south of Kennett Square, Pa., near the town of Landenberg. In Fig. 1 the upper left-hand sketch shows one of the bents, of which there are five, and a section of the original floor system. The five bents with two abutments support six spans, one of 34 ft., four of 40 ft. and one of 70 ft. Calculations revealed that the stringers were good for only 2-ton trucks, the main material of the girders and floor beams for 8- to 9-ton trucks, and the main material of the columns for 15-ton trucks (H-15 loading). The details and bracing in general were inadequate. It was desired to strengthen the bridge for H-15 loading.

The lower left-hand sketch in Fig. 1 shows a typical bent after the reinforcing was completed. In addition to the changes shown, longitudinal bracing was added in one of the 40-ft. spans, bottom horizontal bracing was placed in the 70-ft. span, and plates were added to reinforce the pins in this long span. The original 1-in. horizontal rod bracing was allowed to remain in the structure, but the intersections were all welded to prevent rattling. The lowering of the floor beams about 7 in. to accommodate new 12-in. I-stringers was an important feature of the reconstruction. The rivets connecting the flange angles to the webs of the floor beams and girders were not sufficient to transfer the horizontal shear, so that it was necessary to add some welding at the toes of the angles. Fig. 2 shows the stringer, floor beam and girder details.

Calculations determined the maximum allowable dead load for the bridge deck to be 75 lb. per sq.ft., without overstressing the various members after they were reinforced. Wood in any form was not given serious considera-

tion, but the following permanent floors were specified:

	Lb. per Sq.Ft.
Interlocking channels with asphalt plank	45
Steel grid with concrete filler	52
Bar-truss reinforced-concrete slab	72

The 72-lb. floor was selected because its cost was less than the others. It consists of a 6-in. concrete slab (1:2:3½ mix), reinforced with shop-fabricated resistance-welded trusses as shown in Fig. 3. The trusses are made of two ½-in.-diameter rods for each of the chords, with a continuous ⅞-in.-diameter web rod bent to form a Warren-type truss. Spaced on 6-in. centers, they were assembled into 8x17-ft. mats and shipped to the bridge site. The spacing of the trusses is preserved by means of ⅜-in.-diameter longitudinal rods set 9 in. on centers and welded to the trusses top and bottom. In the field the longitudinal rods were lapped and welded to make the reinforcing continuous.

On the under side of each reinforcing mat four 1x¼-in. flat bars were welded to provide a continuous and even bearing on top of the plate girders and the new 12-in. I-beam stringers. These flat bars were welded to the supporting steel members. An edge plate, 6x¼ in., was welded to the ends of the trusses and acted as a form for the concrete. The contractor used high-early-strength cement and was permitted to open the bridge to traffic six days after pouring the last section.

The repair of this bridge required 36 tons of copper-bearing structural steel and 20 tons of reinforcing mats. A total of 55,000 lin.in. of welding was applied. The bridge was closed to traffic for 40 days. Harry K. Ellis is county engineer of Chester County. Stacey H. Widdicombe was consulting engineer, with Carson & Carson as associates. Charles H. Dunleavy was the contractor, and the welding was done by Mellon-Taylor-Hendrickson, Inc., Philadelphia.

A steel-grid floor

Bucks County bridge No. 108, spanning Neshaminy Creek at Newportville, Pa., is a steel structure built in 1903. The upper center sketch of Fig. 1 shows a cross-section at the center of one of the two 87-ft. spans before reinforcing. The stringers were the weakest members in the pony trusses, being good for only 4-ton trucks. The original shop work had been riveted, and the field work was bolted with round-head bolts. The horizontal diagonal bracing for the floor system in the end bays was corroded at the piers and abutments to such an extent as to be useless. The tops of the floor beams in many places were badly pitted.

The lower center sketch of Fig. 1 indicates the principal reinforcing and the new floor system required to make the entire structure capable of carrying H-15 loading. In addition to the reinforcing shown, new horizontal angle bracing was added in the end bays, new bearing plates were placed on the piers and abutments, new end diagonals were placed in the trusses, reinforcing plates were welded to the top chords and, after tighening all the bolts, the joints and connections were welded to take the stresses. A sidewalk was added after letting the general contract and had to be designed to fit special conditions. The abutment ends of the bridge were fixed, and all expansion was taken care of on the center pier.

As in the case of the Laurel Bridge, little consideration was given to a wood floor on the score that it was too expensive in repair and replacement. Calculations showed about 50 lb. per sq.ft. as being the maximum dead load for a floor system, taking into consideration the cost of strengthening the trusses. This dead load eliminated the 6-in. concrete slab from consideration, and therefore the following were specified:

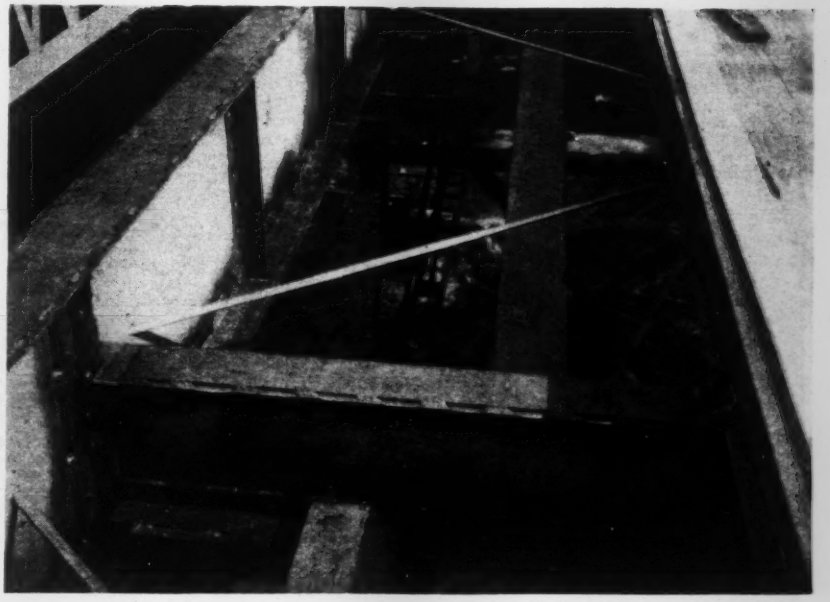


Fig. 2—Wrought-iron floor beams and girders of 45-year-old Chester County bridge were reinforced by new welded coverplates, and toes of flange angles were welded to webs to provide greater horizontal-shear capacity.

	Lb. per Sq.Ft.
Interlocking channels with asphalt plank	45
Steel grid with concrete filler	52

Here again the dollar determined the type of floor, and the steel-grid design was selected. The tees are 3 in. deep, weighing 4.9 lb. per sq.ft. and spaced about 3 in. on centers. The cross-bars are 1x⅛ in., weighing 0.64 lb. per foot and spaced about 4 in. on centers. Edge bars are 3x¼ in. These members were assembled in the shop into units about 4x18 ft.

In the field, shop-punched holes in the flanges of the tees were utilized to plug-weld the floor to the floor beams. In addition, adjacent sections of floor

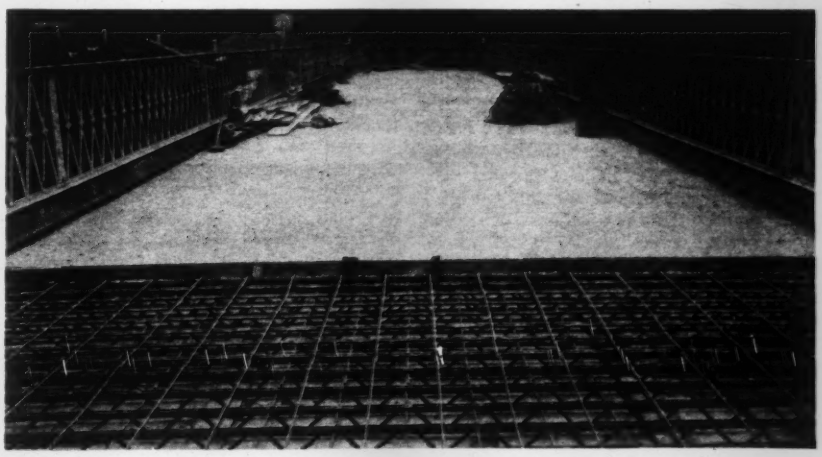


Fig. 3—Six-inch concrete slab reinforced with bar trusses forms new floor of Chester County bridge.

Fig. 4—Pouring concrete on steel-grid floor for bridge near Newportsville, Pa. Extensive reinforcing of steel floor beams, stringers and trusses by welding formed an important part of the work.

were welded together. After the steel floor was erected and welded, concrete (1:2:3 mix) was placed, vibrated and finished flush with the top of the grid. Fig. 4 illustrates the floor ready for concrete with a truck of central-mixed concrete (total weight, 36,000 lb.) on the bridge. The fact that a loaded truck can operate on this type of floor before the concrete is poured proved of considerable advantage. Three days elapsed from the time the high-early strength concrete was placed until traffic was allowed on the structure.

The repair of this bridge required 34 tons of structural steel (not including the sidewalk) and 34 tons of copper-bearing steel in the floor deck. A total of 25,000 lin.in. of welding (not including the sidewalk) was applied. The bridge was closed to traffic for sixteen days. John S. Roberts, Jr., is county engineer of Bucks County. Carson & Carson acted as consulting engineers, M. & J. B. McHugh was the contractor, and the welding was done by Mellon-Taylor Hendrickson, Inc.

Interlocking steel-channel floor

Bucks County bridge No. 116 is a wrought-iron structure of two 80-ft. pin-connected pony truss spans crossing Neshaminy Creek at Bridgetown, Pa. The upper right-hand sketch of Fig. 1 is a typical section of the structure at four of the seven interior panel points. At the other three panel points long floor beams extend about 3 ft. beyond the trusses, with an angle brace to the top chord. The floor beams are on about 10-ft. centers. All shop work was riveted. The horizontal rod bracing in the end bays was useless, having been damaged by floating debris in times of flood. As far as corrosion was concerned, the bridge was in an excellent state of preservation.

The lower right-hand sketch of Fig. 1 shows the principal reinforcing required to increase the capacity from 4 tons (that of the stringers) to two liines of H-10 loading or one line of H-15 loading. Since the bridge was only 16 ft. wide between trusses, it was assumed that only one line of heavy trucks or two lines of lighter vehicles would have to be accommodated at one time. Expansion on this bridge was taken care of at the end abutments, with the fixed ends on the center pier. In addition to the repair work indicated, reinforced concrete was placed around the fixed-end bearings on the pier, new horizontal angle bracing was installed in the end bays, and joints were strengthened by welding as required. For the original 5-in. I stringers new 12-in. 31.8-lb. copper-bearing steel I-beams were substituted. Fig. 5 shows the extent of the new work, the reinforcing and the method of handling the floor system.

The specifications called for one of two type floors, either the grid type with concrete or the interlocking channel type with asphalt bridge planks. In this case the latter proved cheaper and was selected.

The floor consists of copper-bearing steel channels placed alternately with backs up and backs down. The channels with backs up are 8-in.x16.25 lb., and the channels with backs down are 8-in.x13.75 lb. Edge bars, 3½x¼ in., serving as stops for the surfacing plank, were used, and the members were assembled in the shop into units 6 ft. long by 15 ft. 8 in. wide. In this as-

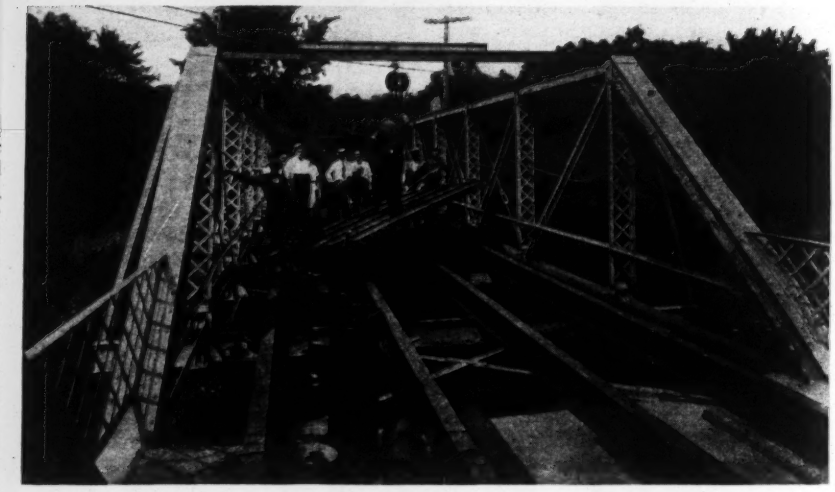


Fig. 5—Installing a shop-fabricated panel of interlocking channel floor on wrought-iron bridge near Bridgetown, Pa.

Fig. 6—Surface of interlocking channel floor of Bridgetown bridge is composed of 1-in. mineral-surface asphalt planks laid parallel to the direction of travel and on top of two 1¼-in. asphalt filler planks placed in the transverse troughs of the floor.

sembling the top edge of the bottom channels and the bottom edge of the top channels were welded to the webs with ⅜x2-in. welds 9 in. on centers. Holes ⅞ in. in diameter were punched to accommodate plug welds in the field. Each unit was cambered 1 in. at the center before it was welded.

In the field the interlocking channel flanges of adjacent units were welded with ⅜x2-in. welds 4½ in. on centers. Installation of the floor units is shown in Fig. 5. The loaded truck, which backed out of the deck as it was laid, had a total weight of 36,320 lb. All units were placed before any field-welding was done. The bridge was completed by the installation of asphalt filler planks and wearing-surface planks. The filler planks, cemented in the transverse troughs, were composed of two 1½-in. asphalt planks. The top wearing surface, laid longitudinally on top of the filler, consisted of 1-in. mineral-surface asphalt bridge planks. A view of both filler and wearing surface plank is shown in Fig. 6.

The repair of this bridge required 24 tons of copper-bearing steel in addition to the 33 tons of channels in the floor. A total of 15,000 lin. in. of welding was applied. The bridge was closed to traffic for eighteen days. The consulting engineers, contractor and welding contractor were the same as for the Newportville bridge.

Welding procedure

In qualifying welders for work on these bridges, lap-weld and fillet-weld specimens were added to the butt-weld specimens required by the American Welding Society code. Also for two of the bridges wrought-iron specimens were used instead of steel.

No trouble was experienced in the varied combinations of welding wrought iron and steel. All indications were that the weld metal penetrated deeper into the wrought iron than into the steel. Both the bare and coated electrodes used conformed to those required for structural steel of 0.13 to 0.18 per cent carbon.

The six welders on the three bridges made a total of eighteen wrought-iron fillet-weld specimens and eight steel specimens. The fillets on these specimens were ⅜ in. and were designed for 2,500 lb. per linear inch. Of a total of 56 coupons cut from steel butt-welded specimens, an average tensile stress of 53,750 lb. per sq.in. was obtained. This represents a factor of safety of 4.1 based on the allowable stress of 13,000 lb. per sq.in. On the steel fillet specimens practically all failures took place in the weld metal, while in the wrought-iron specimens about 70 per cent took place in the parent metal. For the wrought iron the average weld value was 9,280 lb. per linear inch, and for the steel specimens 9,520 lb. per linear inch.

All the vertical and overhead welding on these structures was done with bare electrode, and most of the flat or horizontal work with heavily coated wire. The following gives the cost of repairing and strengthening the bridges.

	Contract Price	Extras	Total	Cost per Sq.Ft
Chester Cty. Bridge 54.	$10,160	$6.13	$10,166.13	$2.26
Bucks Cty. Bridge 108	6,534	140.00	6,674.00	2.09
Bucks Cty. Bridge 116	5,333	00	5,333.00	2.05

The above prices do not include engineering fees. The list of extras seems to indicate that there is a smaller amount of trouble experienced with wrought iron than with steel. The prices per square foot indicate that the cost of the repair work is a small percentage of the cost of a new structure.

Michigan's Experience Shows Need for Liberalization of Relief Act

By John P. Hallihan
Chief Engineer, Rapid Transit Commission, Detroit; Member, Michigan Committee for Trade Recovery

IN THIS TIME of wide-spread unemployment and consequent distress, numerous remedial measures are being proposed. One of the most interesting of these measures, because of the spirit of fairness on which it rests, is that of sharing the work that is still available so that two persons may work part time to do the work now performed by one.

While this proposal deserves praise as a humanitarian relief measure and is undoubtedly inspired by the highest motives, it is admittedly a temporary expedient. Unaccompanied as it is by any provision for new and productive employment, it carries the implication that the country offers no possibility of further betterment and that we must accept the situation as it is for an indefinite period.

This is a defeatist idea and is, moreover, not in keeping with the facts that have been developed by the most intensive investigation of the public works and general building situation that has ever been made in the history of the country. It seems further to lead to a practical dole basis as against self-respecting jobs that may be produced by the creation of community assets in the form of needed public improvements.

That there are deferred public improvements in volume several times greater than can be financed within the one and one-half billion dollars available under the provisions of the Emergency Relief and Construction Act of 1932 is evident from inspection of the figures.

Public construction far below normal

In the eight-year period ending in 1930 the average building volume for public and private works was seven to eight billions. The volume has been dropping steadily since 1929 and in 1932 was below three billions, or barely more than one-third of normal.

Let us consider the state of Michigan as typical of the nation. In normal times the volume of building is about $350,000,000. In 1932 it is about $52,000,000, of which $40,000,000 is in public roads.

In October, 1931, the Michigan Committee of Engineers and Employment, which is the state subcommittee of the President's Organization for Unemployment Relief, commenced developing facts concerning unemployment, possible projects, financial position and tax delinquency of Michigan cities. Its progress report in April, 1932, showing the vital necessity of resuming the construction of public works and justifying the loan of the national credit, was corroborated by similar committees in other states. A coordination of effort of the numerous bodies working along parallel lines was effected in June, 1932, under the banner of the National Committee for Trade Recovery, with similar subdivisions in the 48 states, and the work in Michigan has since been carried on under these auspices. We have, therefore, a fairly intimate knowledge of the number of jobs available in Michigan and the number of jobs that may be created by the 30-hour week.

We have come to the reluctant conclusion that the unemployment situation in Michigan is daily getting worse instead of better. A year ago 15,000 families were on the welfare roll in Detroit, the nerve center of the state. Today there are 32,000 families receiving direct relief. The number of jobs that might be shared is fewer today than it was a year ago. Tax delinquency, which a year ago was 26 per cent, is now 36 per cent. The amount of money being spent in direct relief is much greater than it was a year ago; $27,000,000 was spent in Detroit on direct relief from July 1, 1929, to July 1, 1932, and $10,000,000 is estimated for the current fiscal year. The state has spent approximately $100,000,000 in direct relief since 1929. The programs of public works, which constitute the backlog of employment in ordinary depressions, have been entirely discontinued throughout the state for nearly

two years, with the single exception of the work on public roads, which is financed by the weight tax on automobiles and the gas tax. Singularly enough, these revenues have shown no essential change since 1930.

Much work to be undertaken

A law has been passed which prohibits the issuance of bonds for new construction by cities having a tax delinquency of 25 per cent. This affects today numerous cities in the southern peninsula of Michigan. On the other hand, we find that in almost every city in the state there are necessary public works that should be under way and that can be made to come within the self-liquidating provisions of the Emergency Relief and Construction Act of 1932. These consist, in part, of water-supply projects, extensions of water mains and water-softening projects, all carried by service rates that can be pledged as security. The aggregate of these projects would reach $20,000,000, and under the 30-hour rule would put 24,000 men directly to work for a year, with an equal number engaged in the supply and fabrication of materials. There are 76 cities in the hard-water belt that are within the economic range in which municipal water-softening plants are found to be cheaper than individual plants. The economic limit in this respect is cities of 4,000 population.

Sewage-disposal projects, which under state legislation passed in 1931 can also be put on a service-rate basis, represent a total approximating $30,000,000, which would give employment to 36,000 men for a year, with an equal number of indirectly employed. The Stream Control Commission reports 40 cities that should now install sewage-treatment plants, or come under the ban of the department of health for stream pollution. Certainly a country has not reached the limit of productive construction as long as some of its communities dump raw sewage into the streams from which other communities derive their water supply.

With the exception of the Detroit district, the great majority of these projects are in cities that are not hampered by the provisions of the act prohibiting bond issues, because their tax delinquency has not reached 25 per cent. They are well within the bond limitations of the home rule act applying to cities. Their financial affairs are in condition that should be satisfactory to the loan committee of any bank. The local banks are not loaning money to cities for public works, but the R.F.C. is willing and able under the law to finance these projects to the extent of one and one-half billion dollars. Application for loans is, however, dependent upon the initiative of public officials, and in this state the bonds or notes, or other general obligations that may be issued, must be authorized by a 60 per cent vote of the electors voting upon the question.

Campaign to arouse public interest

The state has been divided into zones, zone chairmen and local committees have been appointed, and a campaign has been instituted to induce public officials to get this work started. More than 100 engineers and business men have been assiduously employed in this effort since July 1. Since November the committee has had the assistance of the equipment companies, including the Westinghouse E. & M. Co., the General Electric Co., the Fairbanks-Morse Co., the Allis-Chalmers Co., the Worthington Pump Co., the Portland Cement Association, the sand and gravel industries, the Standard Oil, Sinclair and other distributing companies. Their sales forces have been organized and are daily preaching the gospel of the resumption of public works. With all this effort very few cities have so far developed projects in the form of applications to the R.F.C. that could be made acceptable. One city has submitted a sewage-disposal project to the voters three times in the past year, only to have it rejected.

Public officials fear to act

The trouble, as we see it, is that the national demand for reduction of taxation at any cost has instilled a fear in the minds of public officials so strong that they see a loss of public favor in the event of their indorsing a public-works project, no matter how badly it may be needed nor how well justified it may be as a community asset nor how completely it fills the specifications of the Emergency Relief and Construction Act of 1932 for a loan from the R.F.C.

We are in the very unusual and anomalous position of having the financing already available for needed public works at a time when those works can be constructed at 75 per cent of normal costs and a great saving effected to the taxpayers, when the necessity of creating productive employment was never more imperative, and yet with almost a complete inability to get the machine going because of the failure of the general public, and equally the leading citizens, to recognize the situation as an opportunity.

At the same time the communities find themselves confronted with an increasing demand for welfare funds against resources which are decreasing every day so rapidly that presently it will be beyond their power to borrow even for direct relief.

Our problem, therefore, is to break this vicious circle, or rather the descending spiral, since the resources decrease while the need increases. If we can translate relief money into work requiring materials as well as labor, we not only reduce the number requiring relief but we create a community asset, produce a margin above living expenses for the workers, thus creating buying power and finally restoring private industry.

The mayor of the city of Detroit has constituted a citizens' committee to investigate self-liquidating projects, and other cities are being urged to follow this example. The Detroit committee consists of a banker, a real estate operator, a telephone executive, a labor leader, a steel fabricator, a contractor, an architect and two engineers—a fair cross-section of the citizenry. It took this committee all of three days to dig up twenty million dollars' worth of self-liquidating projects, in the basic services of water supply, sewage disposal and garbage incineration.

Time for energetic action

It is time to treat the situation with the seriousness that it deserves, to get back in the domain of practicality and common sense. It is time to treat this emergency as an emergency and cease expecting it to cure itself. We can see no hope in the welfare program alone. We can see a great deal of hope in the resumption of necessary public works, in the heartening of men, in the restoration of purchasing power beyond a bare living, in the consequent stimulation of private industry.

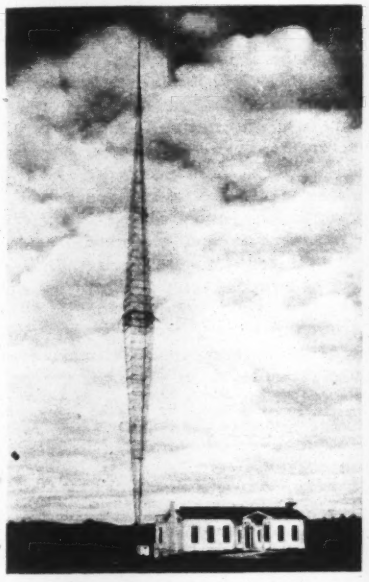
Bankers, business leaders and tax reformers must be convinced of the false economy in compelling municipalities to pledge their taxing power for relief loans that produce nothing but that nevertheless must ultimately be paid back from taxation, rather than to aid them to change to a policy of creating productive employment by the construction of actual community assets in the form of needed service facilities.

We know from reports of other state committees of the National Committee for Trade Recovery that the situation depicted is the situation in every other state in the Union, with the important exceptions of California and Louisiana, which have borrowed 102 and 40 millions respectively and have gone to work.

It should be understood that even after a project is agreed upon that the delay due to production of plans, to the statutory delays of legal procedure in submitting the proposal to a vote, to the readjustment of limiting statutes to permit municipalities to borrow money for emergency work, to the necessary liberalization of the language of the Relief Act itself to permit revenues to be used as security that come from tax resources but are applied to creation of basic services that from their nature cannot be put on a strict utility basis, all must be worked out; and delays of this character will consume the whole of this winter before men can be actually put on the job. United action in removing impediments is vitally necessary if the loan of the national credit offered for self-liquidating projects under Title II of the act is to be utilized in the construction season of 1933.

Radio Tower 878 Ft. High Built at Nashville, Tenn.

A SINGLE structural-steel tower 878 ft. high comprises the new radio antenna of station WSM at Nashville, Tenn. It is said to be the tallest radio antenna in the world and is owned by the National Life & Accident Insurance Co. Resting on a double-cone porcelain insulator at the base, the galvanized tower is held vertical by eight guys at the 370-ft. level. The tower is 2½ ft. square at the base and 38 ft. square at the guying level, tapering to about 3 ft. square at the 758-ft. level, where it is surmounted



New radio tower or "vertical radiator," recently completed for station WSM at Nashville, Tenn., reaches a height of 878 ft. and is said to be the tallest radio antenna in the world.

by a tubular steel pole 120 ft. high. Its total weight is about 150 tons.

Antenna of new type

In the more familiar type of radio antenna two steel towers carry a horizontal wire, with a downward lead in the center or at one end. The vertical wire is by far the most important element and, for maximum efficiency, its length should be somewhat greater than one-half the wave length of the station. Inasmuch as this necessary height is from 400 to 1,000 ft., practical considerations have until recently prevented the attainment of the theoretical results. The single tower at station WSM and similar installations made elsewhere within the past year are planned to simulate the vertical wire, and at the same time to eliminate the horizontal wire and its supporting towers. The single towers have been called "vertical radiators."

The Nashville tower was designed to withstand a wind pressure of 30 lb. per sq.ft. The eight guys are broken up into short lengths by porcelain insulators of the compression type, so as to minimize the effect of the cables on the radiating characteristics of the tower. The guy cables are 2 in. in diameter, of high-strength steel bridge wire prestretched by the rope manufacturer so as to insure a uniform modulus of elasticity. Concrete foundations for the guy anchorages and the tower were set on rock which was within 3 to 5 ft. of the surface.

In the design of the vertical radiator an aluminum conductor is run up each of the four corner legs to secure the maximum possible electrical conductivity. According to the Blaw-Knox Co., who designed and built the vertical radiators, these aluminum conductors are more in the nature of a precautionary measure, inasmuch as the conductivity of the structure itself is quite adequate.

Material for the vertical radiator was shipped knocked down, and all connections were made by bolting in the field, with the exception of those in the bottom 15 ft., which were shop-bolted. During erection the tower was held in position by temporary guys until the 370-ft. level was reached at which time the permanent guys were attached and brought to the proper tension. After the removal of the temporary guys the erection continued by building up the panels. The structure was erected by the Blaw-Knox Co. in somewhat less than two months.

Letters to the Editor

Wood Preservation by Brush Treatment

Sir—We have been familiar with your paper for almost 50 years, and we consider the information you furnish as valuable and reliable. We therefore take exception to the sentence appearing in your Nov. 24 issue, p. 633, reporting discussion at a meeting of the New York group of the American Society for Testing Materials. The report quoted Dr. Hermann von Schrenk as saying: "Impregnation is the only efficient method. Painting of preservatives is a waste of money."

Admitting that *proper* impregnation is an efficient method of wood preservation, the fact remains that impregnation or pressure treatment is not feasible and practical on many occasions, and in such cases the use of some preservative in some other way is surely better than the use of none at all.

In construction work or on bridges a brush treatment applied to cuts, splices and holes is beneficial even to creosoted wood, which otherwise would be vulnerable. Of course, for such superficial application a specially adapted preservative is necessary. For bridge work, the treatment should not merely protect against organisms from polluted waters, but it must not increase the fire risk. Improper treatment is apt to reduce the tensile strength of the wood and lessen the holding power of spikes.

Without giving information on species of timber, quality, quantity, preserving method used and climatic exposure, one of the A.S.T.M. members estimated a life of 26.6 years for creosoted timber, while another member related that wood preserving had a very meager beginning about 25 years ago. It seems that these statements are somewhat divergent.

As to the value of a suitable preservative for brush treatment, foreign records covering 50 years or more are available, as well as service records covering over 25 years from this country. The chief engineer of one of our principal railroads writes under date of Nov. 1, 1932: "Some years ago we used a brush treatment with your product on a number of overhead bridges, which lasted from 21 to 23 years, compared to a life of 12 to 15 years untreated." From another chief engineer of an important system there is available a complete service record on yellow-pine bridge ties and timber which received a treatment of 4 gal. per 1,000 ft. b.m. in 1908 and were reported in good condition on Feb. 7, 1929. This is a main-line bridge subject to heavy traffic. The annual charge between the two dates, basing cost on latest quotations in your paper and estimating treated and untreated life at the A.S.T.M. figures, would be in this case, per tie:

Untreated bridge ties and timber	12.5c.
Creosoted	5.67c.
Carbolineum treated	5.34c.

Still better results can be shown with a 34-year record on 45-ft. poles, brush-treated, set in Nebraska soil in 1898 at a cost of $6 for pole and treatment. Assuming actual service life to be from 1898 to 1932, the annual charge per pole would be: untreated, 78c., and carbolineum-treated, 18c.

A good many of these poles are still in service at this writing, and replacement costs avoided are not included in the charge computed.

A. LEYPOLDT,
General Manager,
Carbolineum Wood Preserving Co.
Milwaukee, Wis.
Dec. 13, 1932.

Book Reviews and Notes

A Monthly Commentary on Current Additions to the Civil Engineers' Library

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Pure Water and Public Health

SANITATION OF WATER SUPPLIES—By Murray P. Horwood. Cloth; 6x9 in.; pp. 181; photographs, tables and line drawings. Published by Charles C. Thomas, Springfield, Ill. and Baltimore, Md., $3.

The approach to the subject of water-supply sanitation in this little volume is somewhat different from that in most published material on the topic. Engineering aspects are touched upon only incidentally, and the whole water-supply subject is discussed from the viewpoint of the public health administrator. This does not mean that the treatment is popular or non-technical but only that the disease-prevention aspect of water-supply control is the primary subject of consideration. As the author states in his preface, "Particular emphasis has been placed on the practices that are necessary in order to maintain or render a water supply potable and safe, since this is the first requirement of a municipal water supply." Nevertheless, engineers in the water-supply field will find here some valuable information as well as interesting reading. The historical aspect of water-supply control and sanitation in general measures are especially worthy of attention. Water as a vehicle of disease and methods of disinfection are subjects that are given extended treatment. The author is an associate professor in the department of biology and public health at Massachusetts Institute of Technology.

* * *

Acoustics in Architecture

ACOUSTICS AND ARCHITECTURE—By Paul E. Sabine, Riverbank Laboratories. Cloth; 6x9 in.; pp. 327; illustrated. Published by McGraw-Hill Book Co. Inc. New York and London. $3.50.

No one element that should enter into the design of many buildings has been as widely disregarded as acoustics. This neglect has been all too apparent in many auditoriums, but many other inclosed areas also have suffered in efficiency through failure to control sound propagation. Much of this condition was due to lack of usable information on the behavior of sound in rooms. The present book is an attempt to supply such information. It gives a concise discussion of the nature and properties of sound, sustained sound in an inclosure, reverberation, measurement of absorption coefficients and the sound-absorption coefficients of materials. Application of the principles developed to rooms and auditoriums is discussed. Other subjects covered are the theory and measurement of sound transmission, measurement and control of noise in buildings, the transmission of sound through walls and the isolation of machines. The author's purpose is to bring together for the convenience of both student and practicing architect or engineer the results of recent studies in the application of theories to practice.

* * *

For Engineers and Bankers

AMORTIZATION TABLES—Compiled by Edwin Hancock, consulting engineer, Chicago. Leatheroid; 4⅛x7⅛ in., pp. 30. Published by The Citizens Publishing Co., La Grange, Ill. $3.

The tables show the amount of money required each year to amortize bond issues, running from 2 to 40 years with interest at 4½, 5, 5½, 6, 6½, 7 and 8 per cent. Amortization of a $1,000 bond is the basis. A column showing the total payment for each year of both principal and interest is followed by columns showing the amount of principal paid off each year up to 40 years. The total payment column was calculated by the following formula $\frac{\$1{,}000\,(1+r)^n r}{(1+r)^n-1}$ in which r equals rate of interest and n equals the number of installment payments. The tables form a handy reference for engineers, lawyers and investment houses. It is of particular value in working up special-assessment payments, which are always based on equal annual payments to arrive at even $1,000 bonds.

* * *

An Aid to Sewerage Design

TASCHENBUCH DER STADTENTWASSERUNG—By Karl Imhoff. Cloth; 5x7 in.; pp. 151; line drawings and tables. Published by R. Oldenbourg, München and Berlin, Germany. 5.20 R.M.

The purpose of this small volume, the sixth edition of Dr. Imhoff's periodically revised "Taschenbuch," is to provide in quickly usable form the numerical data required by an engineer in designing a sewerage system or treatment plant, and it does so admirably. No attempt is made to develop a treatise on the subject, and the discussion is confined to quantitative subjects. The first 50 pages or so are devoted to the general principles of sewerage and the hydraulic and structural design of sewers. In the remaining pages there are presented in compressed form the numerical data applying to sewage treatment and disposal, including sewage analysis, disposal by dilution, screens, skimming tanks, grit chambers, settling tanks, sludge treatment and chemical and biological methods of secondary treatment. There are also provided several examples of sewage-plant computations.

Moment Distribution In Structural Design

CONTINUOUS FRAMES OF REINFORCED CONCRETE—By Hardy Cross and Newlin Dolbey Morgan. Cloth; 6x9 in.; pp. 343. Published by John Wiley & Sons, Inc., New York, and Chapman & Hall, Ltd., London. $4.50.

THE TITLE of this book, while strictly correct, is not adequately definitive of its scope and content. It is a more important book than its title indicates. The text is built around the senior author's concept of fixed-end moment distribution as a design tool, so that the book is essentially a presentation of a single method of indeterminate structure design rather than a textbook or treatise on continuity in reinforced concrete. This method, moreover, has received such wide acceptance and trial in the past two or three years that it warrants such emphasis. Also the text applies almost equally as well to steel structures as to concrete.

An interesting characteristic of the book, which adds to its readability and usefulness, is a terse and pointed manner of expression, many ordinary facts being presented in almost epigrammatic style. For example:

"We must always remember that what we want is a structure, not merely an analysis."

"Analysis must be thought of as a guide to judgment, not as a substitute for it."

"Methods of analysis serve to make this picture (of the deformed structure under load) accurate; but unless, after we have analyzed the structure, we can draw its deflected shape, we do not know what we are talking about. . . . The more or less gentle reader may find the constant repetition of this theme monotonous, but it is the deliberate conclusion of the authors that the most important aspect of the subject is the simple picture of structural deformation."

"The statement frequently made that structures of reinforced concrete are not truly elastic in the sense that they do not have complete elastic recovery is perfectly true and entirely immaterial. But the fact that structures of reinforced concrete are not truly elastic in the sense that we cannot predict with accuracy and certainty the exact angle change per unit of moment per unit of length from one section to another of a beam is also true and is very pertinent.

"Too many students of indeterminate structures hope to progress by acquiring an endless variety of tools, and are so busy doing this that they never learn how to use them."

"There is the danger that students will finish their study of indeterminate structures without understanding the application of analysis to design—all dressed up intellectually, but not knowing where to go."

"What is eruditely called the theory of elasticity deals with the simple fact that if a structure does not break, it holds together . . . It might better be called the theory of continuity."

"The method of moment distribution is a method of thinking about what is happening in the structure; the column analogy is a mechanical tool for analyzing the structure."

"An influence line is a somewhat sophisticated device. If one is accustomed to the use of charts as tools of thought, it is an extremely valuable conception; it is even useful to those who employ charts as a substitute for thought. Influence lines are not essential to the understanding of any structure, either determinate or indeterminate."

The first chapter of the book is devoted to emphasizing the importance of being able to visualize deformation in indeterminate structures before any design is started. A chapter is then devoted to the statics of deflected structures and points out the usefulness of free-hand sketching to secure a picture of the deformation of the structure, its moment and shear diagrams. The third chapter is devoted to the geometry of deflected structures, including the "column analogy" (a mathematical relationship between the moments produced by continuity and fiber stresses in a short eccentrically loaded column), which is the basic tool used in moment distribution. A brief review of the geometry of influence line is taken up, after which the reader is launched into the machinery of moment distribution and its application to continuous girders, rigid frames, including multi-story buildings subjected to wind, secondary stresses in trusses, etc. A chapter is devoted to influence lines and another to the analysis and design of reinforced-concrete arches.

Railroads of Brazil

PUBLIC AND PRIVATE OPERATION OF RAILWAYS IN BRAZIL—By Julian Smith Duncan. Cloth; 6x9 in.; pp. 243; maps and tables. Published by Columbia University Press. $3.75.

THREE TYPES of railroad operation are practiced in Brazil—federal, state and private. The book under review is an analysis of these three systems in an attempt to make deductions as to the advantages or disadvantages of each. The railways of Brazil were built largely by private companies aided by government subsidies. Most of them were built in advance of needs in an attempt to develop the country. The subsidies took the form of guarantees of interest on bonds at a fixed amount per kilometer of line built, freedom from duties on construction supplies, and special-privilege zones. Basing subsidies on kilometers of line built was unfortunate, as it resulted in unnecessarily crooked and poorly located lines.

Profitable lines remain in private hands. The unprofitable have had to be taken over by either federal or state governments. The governments now bear the cost of their neglect in not seeing that the subsidized lines were properly built.

Because the railroads are not parallel and competitive, also because the privately operated railroads are the cream of the country's systems, no direct comparison of private vs. public operation is found possible. Certain significant things stand out, however. Physical plant and standards of maintenance are better on state and privately owned lines, but the service on the federal-owned lines is better than when in private hands. These lines are overstaffed, and rates are frequently below cost. Local pride so far has resulted in management of the state-owned lines on a basis comparable with private operation, but as the state ownership is of recent origin it is not possible at this time to determine whether political patronage will result in excess staffs there as on the federal lines.

Miscellaneous Notes on Booklets and Reprints

DURABILITY OF PREPARED ROLL ROOFINGS; Bulletin 109, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.

COLUMN CURVES AND STRESS-STRAIN DIAGRAMS; Research Paper No. 492, U. S. Bureau of Standards. For sale by Superintendent of Documents, Washington, D. C. Price 5c.

DESTRUCTION OF CARBOHYDRATES and Organic Acids by Bacteria from a Trickling Filter; Bulletin 110, Iowa Engineering Experiment Station, Iowa State College, Ames, Iowa.

THE MANY LABORATORIES of Rensselaer Polytechnic Institute (Troy, N. Y.) are described in the institute's Bulletin No. 3, Vol. 31. Four of the institute's buildings are now given over largely to the physical, chemical, biological and minerological laboratories and the laboratories of the departments of civil, mechanical and electrical engineering.

LIQUID ASPHALTIC ROAD MATERIALS recommended by the Asphalt Institute (801 Second Ave., New York) are given in a pamphlet which supersedes earlier pamphlets Nos. 1 to 7 inclusive, previously issued. Copies free.

SMALL-DWELLING CONSTRUCTION is the subject of Building and Housing Publication No. 18, U. S. Bureau of Standards, entitled "Recommended Minimum Requirements for Small Dwelling Construction." It is a report to the building code committee of the department by a subcommittee headed by William K. Hatt. The present edition is built upon a report of the same name issued some years ago. Copies may be obtained from the Superintendent of Documents, Washington, D. C. Price 10c.

MAP COLLECTIONS in the District of Columbia, a descriptive list as of July, 1932, of 44 collections of maps in the National Capital, most of which are available for consultation. Compiled by the Board of Surveyors and Maps of the federal government, Room 6206, Interior Department Building, Washington, D. C. Free on application. Maps for sale are noted in the descriptions.

RECOMMENDATIONS FOR ECONOMIES in the state government of New Jersey are contained in a survey made for the state by the School of Public and International Affairs of Princeton University. The recommendations are for the fiscal year 1933-34. The report was made at the request of the governor, A. Harry Moore. Of special interest to engineers is the comment upon the highway department and recommendations for the setting up of a public-works planning commission. Lack of adequate long-range planning by the highway commission and its tendency to give more weight to the demands of local communities than to the opinion of its engineers is criticized in the report.

New Books and Revised Editions

[Those desiring copies of the books listed below or mentioned elsewhere in this section should order them from the publishers or from their local booksellers.]

BEMESSUNGSTAFELN FÜR EISENBETONKONSTRUKTIONEN—By Paul Göldel. Cloth; 7x10 in.; pp. 281; numerous tables. Published by Julius Springer, Berlin. 24 RM.

BRÜCKENÄSTHETIK—By Hermann Rukwied. Paper; 7x10 in.; pp. 112; photographs, line drawings. Published by Wilhelm Ernst & Sohn, Berlin. 9.50 RM.

CONSTRUCTION MÉCANIQUE — By J. Izart. 52nd edition. Cloth; 4x6 in.; pp. 336; tables and line drawings. Published by Dunod, 92, Rue Bonaparte, Paris. 20 frs.

DESIGN OF STEEL MILL BUILDINGS—By Milo S. Ketchum. Fifth edition. Flexible; 6x9 in.; pp. 632; line drawings and tables. Published by McGraw-Hill Book Co. Inc., New York and London. $6.

ERLÄUTERUNGEN — By W. Gehler. Paper; 5x7 in.; pp. 128; halftones, line drawings and tables. Published by Wilhelm Ernst & Sohn, Berlin. 4 RM.

GRUNDLAGEN DES STAHLBAUES—G. Schaper. Paper; 7x10 in.; pp. 287; halftones, line drawings and tables. Published by Wilhelm Ernst & Sohn, Berlin. 22 RM.

RECENT SOCIAL TRENDS—Two volumes—Report of the President's Research Committee on Social Trends. Cloth; 6x9 in.; pp. 1,568; tables and line drawings. Published by McGraw-Hill Book Co. Inc., New York and London. $10.

UNTERSUCHUNGEN AN FAHBAREN FORDERBANDERN FÜR DEN BAUBETRIEB—By Max R. Ehrt. Paper; 8x12 in.; pp. 24; diagrams, halftones and tables. Published by VDI-Verlag, Berlin.

Engineering News-Record

Editor—F. E. Schmitt. Editorial Staff—V. T. Boughton, W. G. Bowman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

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Basic Services in Engineering

A series of articles on the engineering activities of the various federal government bureaus begins in this issue. Widely ramified and diverse in character, these activities are absolutely necessary and basic to many branches of engineering and industry. Although this fact may be generally accepted, its connotations are seldom sufficiently appreciated. As we use the water that is piped to our bathroom so do we use the results and services of these bureaus liberally and often without giving thought to their source or the able and efficient management that makes them available. Typical of federal engineering activities is the work of the Coast and Geodetic Survey, the subject of the first article in this issue. Interesting in its details, the Survey's work is also fundamental to all engineering. Its precise practices affect and guide private work. Its results are literally the benchmarks of all engineering progress and of shipping as well. Likewise the work of the Lighthouse Service, the Bureau of Standards, the Bureau of Yards and Docks, the Indian Service, the Bureau of Reclamation, the Bureau of Public Roads, the Aeronautics Branch of the Department of Commerce, has each its own sphere of influence. By and large, the work is efficiently done and invariably well managed; more often than not these governmental engineering organizations are fit subjects for emulation. But the vital thing is for engineers to understand the work that is being done, and to appreciate its relation and indispensability to their own everyday activity. If this series can help to establish this understanding and appreciation of the basic nature and importance of federal government engineering, its purpose will have been fulfilled.

Industry's New Spirit

More evidence that a new spirit animates industry, as was suggested in this column a few weeks ago, is offered by the decision of the electric light and power utilities to join in the Edison Electric Institute, coincident with dissolution of the National Electric Light Association and the Association of Edison Illuminating Companies. The far-seeing admonition of Floyd L. Carlisle last summer (E.N.R., June 16, 1932, p. 846), when he called upon the electric power industry to direct its view toward the public interest and shape its organization and practice accordingly, finds response in the present action. Standards of service and practice, and power to enforce them, are embodied in the Institute. Its predecessor, the National Electric Light Association, had caused the constructive work of its early years to be submerged by self-interested propaganda, and had lost effectiveness through looseness of organizational structure. Therewith the conception that the power business exists to serve a need on the basis of public acceptance lost vitality. In the face of these changes the rise of influence of the federal trade and power commissions placed the industry in an increasingly false position. A reorientation was due. Meantime, events have been teaching many industries that they are integral service units, that they must organize for efficiency and stability, and that sound principle alone will survive. Great good will accrue if these convictions carry through the lean days into more prosperous times. They will contribute to permanent readjustment of the relation between industry and public, the more surely if the new spirit is supported by far-sighted administration.

Useful Service to the Public

A timely expression of sound thinking is contained in the resolution voted by American Engineering Council last week on the technocracy movement. Under the stress of business discouragements so many minds have been disturbed by the vague forebodings and sinister alarms of the propagandists of the movement that it is of high value to have a clear statement of fundamentals. Convincing force resides in the statement of the resolution that, "There is nothing inherent in technical improvement which entails economic and social maladjustments." Here as well as in its subsequent affirmation that technology offers the only possible basis for continuing material progress, the resolution rests squarely on the essentials of man's development throughout the ages. If these fundamentals have been easily forgotten, their forceful restatement in the Council's resolution should be effective in bringing them back to new and stronger recognition. We need sharp and clear thinking in these days above all. We need to retain and increase our faith in the power of progress as against the counsels of despair. In furthering these ends the action of American Engineering Council constitutes a valuable public service.

Liberalize the Relief Act

Important changes in the Emergency Relief and Construction Act of 1932 were approved during the past week by the board of direction of the American Society of Civil Engineers and the Assembly of American Engineering Council. Changes to liberalize the act are badly needed if its possibilities as a measure for unemployment relief and business stabilization are to be fully developed. The need for such changes was discussed in our issue of Dec. 8, p. 693. Briefly, the changes put forward by the committee on public works of the American Society of Civil Engineers and now approved by that organization and by Engineering Council call for elimination of the self-liquidating restrictions in the Relief Act and substitute the broader limitations of "needful and economically sound"; authorize the R.F.C. to deal with agencies of municipalities in housing matters; add sewerage works, hospitals and schools to the projects already listed, for which the R.F.C. may make loans to private corporations; eliminate the restrictions against projects supported by taxation; and reduce interest rates. These recommendations are conservative; they should make it possible for the R.F.C. to finance a large amount of needed public work without the risk of opening its coffers to unnecessary or wasteful undertakings. Their indorsement by the American Society of Civil Engineers and American Engineering Council should be of material help in getting the act modified.

A Necessary Distinction

THE U. S. Supreme Court has done well to restate the limits upon the amount of new construction that the Interstate Commerce Commission may order a railroad to build against its own wishes. For many years past the Supreme Court has held that states may require railroads to extend or improve existing services but has never permitted that right to be abused through its use to obtain entirely new services. The right has been used to require, for example, two or more railroads serving a city to join in the construction of a new union terminal or to require railroads to relocate their lines through a city to eliminate grade-crossings. Previous to 1920 this right rested only with the states, but the Transportation Act of that year, in a section conferring certain powers relating to car service upon the Interstate Commerce Commission, contained a single phrase which read "and to extend its line or lines." This phrase, the commission has assumed, conferred upon it the right to require unlimited railway extensions, provided the extension is reasonably required in the interests of "public convenience and necessity" and the expense does not impair the ability of the railroad to perform its duty to the public.

Acting upon this interpretation of the law, the commission, in 1929, ordered the Oregon-Washington Railroad & Navigation Co., a subsidiary of the Union Pacific, to extend its line terminating at Burns, in southeastern Oregon, across the south-central part of the state to a connection with the Southern Pacific, a distance of 185 miles. The people of Oregon wanted the line built to open up a rich but sparsely settled section of the state to development. The commission believed that the cost of construction would not be an undue burden upon the Union Pacific System. But the railroad company, believing the line would be unprofitable, took the matter to court and succeeded in having the order set aside.

The Supreme Court on Jan. 9 gave its approval to the action of the lower court. It held the construction of such a line across undeveloped territory could not be interpreted as an extension of an existing service.

The most dangerous element in the interpretation that the commission attempted to put upon the Transportation Act is that it takes from the directors of a railroad a power which they as the managers possess, and vests it in the commission itself, a body that is not responsible to the stockholders. A certain amount of such transfer of power to a regulatory commission is inherent in our system of public utility regulation, but it must be kept within closely restricted limits if the system is not to break down. One complaint made against the I.C.C. is that it has usurped managerial functions too frequently. In the case of new line construction such usurpation is particularly dangerous because of the ease with which public organizations and members of legislative bodies may be stimulated to bring great pressure upon the Commerce Commission. Under such circumstances the commission is placed in a very awkward position, for it is easy to compile a mass of statistics that appears to show that almost any new transportation facility will pay. One has but to review the history of the way in which the federal government has been wheedled into building and improving waterways for evidence of this latter point. And one has but to review that same record to obtain an understanding of what would take place were power to order the construction of new railway facilities put in the hands of the I.C.C.

It is essential that the commission have the power to overrule a too-selfish view on the part of railroad managers and the withholding of money for needed community facilities, but it is equally essential that the power to determine whether large sums of money shall be spent in the development of new territory be left in the hands of those who provide the money. The Supreme Court had done the country a distinct service by re-emphasizing that distinction.

Special Assessments Not Taxes

UNDER the heading "Special Assessment Work Ineligible for R.F.C. Loans" (*ENR*, Nov. 17, 1932, p. 603), we quoted an opinion from the legal department of the Reconstruction Finance Corporation to the effect that "sidewalk, pavement, sewage and other special assessments usually constitute taxation." Because of this ruling scores of millions worth of special assessment work is estopped from consideration. Yet as a matter of fact the Supreme Court has ruled that special assessments are not taxes.

A prominent special-assessment attorney in Chicago, George P. Foster, has written a brief for the Illinois Trade Recovery Committee taking direct issue with the R.F.C. ruling. Quoting Illinois cases, he adds that similar ones can be found for practically every state in the union. The following notes are from Mr. Foster's brief:

"Under the Local Improvement Act of Illinois, only properties which will be enhanced in value by the construction of an improvement may be assessed to pay the cost of constructing such improvement. The amount of assessment is limited to the amount of such enhancement.

The weight of authority in practically every state in the union recognizes a distinct difference between taxes and such assessments. There is a generally understood distinction of the terms. Taxes are burdens or impositions laid for the purpose of general revenue. An assessment is not recognized as a burden imposed upon persons or property, as a tax, but is regarded as an equivalent of compensation for the enhanced value which the property or person assessed has derived from the improvement.

This distinction is recognized and approved by the Supreme Court of the United States in Illinois Central R.R. Co. vs. Decatur, 147 U.S. 190 (13 S. Ct. 293, 37 L. ed. 132), which holds that an exemption from taxation in Illinois does not include special taxation for local improvements. The cases in Illinois and other states hold similarly.

It is a well-settled rule of statutory construction that if words have been given a well-defined meaning by the courts, they are presumed to have the same meaning in the statute. Congress will be presumed to have intended that a word having a judicially settled meaning will have that meaning when used in a statute. (U. S. vs. Merriam, 44 S. Ct. 69; 263 U. S. 179.)

I am of the opinion, therefore, that special assessment under our Local Improvement Act comes within the classification "other means (other than taxation)."

The special-assessment ruling of the R.F.C. legal department probably has discouraged thousands of officials from even looking into the question of financing many an essential project held up because of the inability to sell bonds. It is true that special assessments are burdensome in some cases, but that is no reason why a semi-public corporation should arrogate to itself the prerogative of misinterpreting well-established definitions and thereby depriving the country of the stimulus to employment and business which the Relief Act sought to provide. In the light of the opinion quoted, as well as the R.F.C.'s own prior action in granting loans on benefit assessments, the ruling deserves careful and competent review.

NEWS OF THE WEEK

Loan of $1,991,000 for Seven Projects Approved by R.F.C.

SEVEN LOANS totalling $1,991,000 for self-liquidating projects were approved by the Reconstruction Finance Corp. on Jan. 13. The largest amount was for the city of San Juan, Porto Rico, an amount of $1,300,000 for improvements and extensions of the municipal water system. The city system will be extended to serve neighboring communities, the filtration plant is to be enlarged and 15,000 meters are to be installed.

A loan of $550,000 to the Regents of the University of Colorado for the construction of a dormitory and refectory was approved by the R.F.C., the loan to be effected by the purchase of bonds bearing interest at 5½ per cent to be paid serially within a period of 24 years.

The remaining loans authorized were small. The corporation agreed to loan $20,000 to the Riverton Pipe Line Co. of Riverton, Utah, for a reinforced concrete storage reservoir and pipe replacements; $50,000 to the city of Pensacola, Fla., for additions and extensions to the city waterworks systems as a fire protection measure; $15,000 to the Fabens Water Co. of Fabens, Texas, to extend the city's water distribution system; $40,000 to the Reeves County Water Improvement District No. 1, Balmorhea, Texas, for repairs to the irrigation system due to flood damage; and $16,000 to the city of Quincy, Fla., for replacing a deep well pump, water softening unit and a storage tank.

New loan applications

The principal application among the new ones made to the Reconstruction Finance Corp. is one for a loan of $4,500,000 for completion of the hydro-electric power project of the Central Texas Hydro-Electric Co., of Seguin, Texas. The project, known as Hamilton Dam, is on the Colorado River in the vicinity of Burnet, Texas. It was described in the Jan. 12, 1933, issue of *Engineering News-Record*, p. 59.

The city of Galveston, Texas, is reported to be seeking a loan of $500,000 for the construction of additional coast protection works.

A loan of $25,000 for the construction of a stadium at North Carolina State College, Raleigh, N. C., is being sought by the college officials.

The town of Stratford, Conn., has applied to the R.F.C. for a loan of $1,500,000 for the construction of a sewerage system, a dike and reclamation of 1,100 acres of salt marsh and shore property in the Avon Park section.

Notice that the plans for the Brownsville, Texas, deep-water port and terminal have been approved by the Chief of Engineers will be followed immediately by an application to the Reconstruction Finance Corporation for a loan to finance construction of the port. The Brownsville Navigation District, which will make the application, will seek to obtain a loan of between $1,500,000 and $2,000,000. District's bonds of $3,500,000 will be put up as security. A 250-foot channel to Brownsville is to be dredged, and the Federal Government is to develop the outer channel and build the jetties.

Moffat Tunnel Bond Review Denied by Colorado Court

The Colorado supreme court has refused to reopen the case of the validity of the excess bonds sold to build the Moffat tunnel. The state court by a vote of 4 to 3 accepted the ruling of the Federal courts, calling the full $15,720,000 issue of the bonds valid. The taxpayers had loaned their credit to the initial issue of $6,720,000.

Levee Breaks on St. Francis Flood Lowlands

Flood waters poured through four levee breaks along the St. Francis River in southeast Missouri and northeast Arkansas on Jan. 5. Two gaps in the levee on the Missouri side of the river sent water over approximately 40,000 acres of lowlands. The second of the breaks was 3½ miles north of Kennett, Mo. Another crevasse developed at the boundary between Arkansas and Missouri. It threatened to overflow a 35 square mile area in Arkansas. Water poured through a fourth opening at Bertig, Ark., covering a wide area of farm land.

Relieved by the breaks, the St. Francis started falling and further danger from breaks may be eliminated. The stream fell more than a foot in the area around Kennett. No lives have been lost but some livestock has perished.

Federal Relief Act Liberalization Recommended by Engineering Council

LIBERALIZATION of the Relief Act, business stabilization, technocracy, and many bills now before Congress were considered and acted upon by the Assembly of American Engineering Council at its annual meeting held in Washington, D. C., Jan. 13. Discussion was active and wide differences of opinion were expressed on most subjects except technocracy, which was universally condemned. Views differed on the Relief Act but it was accepted as an accomplished fact and a considerable majority favored liberalization as outlined in recommendations made to board of direction of the American Society of Civil Engineers by its committee on public works.

Two civil engineers were elected vice-prsidents of Council. The new incumbents are John F. Coleman, of New Orleans, a member of the engineering advisory board of the Reconstruction Finance Corporation and past president of the Am.Soc.C.E.; and William H. Woodbury, of Duluth, past president of the Minnesota Federation of Architectural and Engineering Societies. New faces on the administrative board include H. P. Charlesworth and Francis J. Chesterman, representing the A.I.E.E.; H. S. Crocker and George T. Seabury, representing the Am.Soc.C.E.; Paul Doty, representing the A.S.M.E.; G. H. Fenkell, of Detroit, and George S. Knapp, of Topeka, new regional representatives.

Council went on record in favor of liberalizing the Emergency Relief & Construction Act to aid the directors of the R.F.C. in administering it and recommended that it may be desirable, (1) to remove the self-liquidating stipulation; (2) limit projects only to those which are needful and economically sound; (3) provide that a municipality may set up such agency as may be satisfactory to the Reconstruction Finance Corporation to regulate rents, etc., in housing projects; (4) increase the kinds of work devoted to public use which are eligible for loans; (5) remove the restriction relative to taxation; (6) and reduce interest rates on loans to the lowest figure consistent with the condition that the government shall be fully reimbursed for its loan.

The question of a 6-hour, 5-day week was dismissed with the comment that while Council is not opposed to the short-work week in principle, it is opposed to compulsory legislation such as the Black bill which would bar interstate commerce in goods produced by over-time labor.

Council received and authorized the release, as a progress report, of an elaborate study by its Committee on Economic Balance of the causes of the depression and an analysis, without endorsement, of 24 plans that have been put forward for business stabilization. The analysis constitutes a cross-section of the character of thinking that has been fomented by the depression and is a vivid demonstration, according to Ralph E. Flanders, the chairman, that there is no panacea for the present situation.

Action on technocracy

Technocrats were condemned by Council as "capitalizing the fears, miseries, and uncertainties due to the depression" and as having "proposed a control which is, in effect, class dictatorship."

The text of the resolution follows:

The statements of a group of men organized under the name "Technocracy" have received wide publicity through the press by reason of startling predictions which involve a complete overturn in our economic structure. These pronouncements, circulated as coming from engineers, have led to the belief that they represent responsible engineering thought.

Many requests for information on tech-

nocracy have come to American Engineering Council, which is the representative of national, regional and local engineering societies in the United States. The Council has endeavored to obtain from the promoters of the movement an authoritative statement of their findings and their program. It is significant that no information could be obtained beyond what has appeared in the press.

The accepted practice among engineers of presenting new developments to some engineering society for critical study and discussion has not been followed. The data and statistics brought forward in magazine and newspaper articles as a basis for speculative claims are open to question; some of the findings have been discredited or disproved by other investigations.

These statements and conclusions may have the serious effect of undermining public confidence in our present civilization; and they hold out an unwarranted promise of a quick solution of economic ills. The method of presentation has been marked by exaggerated, intolerant, and extravagant claims. They have capitalized the fears, miseries and uncertainties due to the depression and have proposed a control which is, in effect, class dictatorship.

Contrary to these claims, there is nothing inherent in technical improvement which entails economic and social maladjustments. Indeed technology offers the only possible basis for continuing material progress. The volume of goods produced, distributed, and consumed during the years 1928 and 1929 was not excessive. That volume may and should be surpassed upon the return of prosperity.

The alleged unmanageability of a machine economy has not been proven. Its dislocations are traceable to improper and unskilled use rather than to inherently harmful characteristics. Complete replacement of men by the machine is precluded by the law of diminishing returns. Instances are increasingly in evidence. Contrary to the pronouncements of Technocracy, applied science holds the promise of better things to come in a society which fearlessly and intelligently meets its problems. It is the considered opinion of American Engineering Council that our present economic structure contains within itself the possibilities of progressive improvement and of the attainment of higher standards of living.

A resolution expressing Council's admiration of the record and splendid service of Herbert Hoover was unanimously adopted.

Taxation was the theme of an address by President W. S. Lee and a letter from C. E. Grunsky, past president. In response to the suggestion that Council consider this problem, heretofore regarded as foreign to its sphere, the executive committe was authorized to appoint a special committee to study various aspects of taxation.

Board of water resources

Creation of a federal inter-departmental board of water resources to coordinate the scientific investigations along this line of numerous government agencies as a prelude to establishment of a bureau of water resources in a department or division of public works that may come with government reorganization, was recommended by Council. With reference to the broad subject, Council's officers were authorized to acquaint the Roosevelt administration with its policy.

In recording its position on pending legislation, Council voted to support the Cotton bill to regulate grazing on public lands and to endorse, in principle, a bill to promote American air-transport services in foreign commerce. Council also favored, as a general principle, the extension of federal regulation to all forms of interstate transportation and approved the draft of the state mechanics' lien act.

Council opposed pending bills to lease Muscle Shoals, to abolish the National Advisory Committee for Aeronautics and to cut off appropriations for reclamation. The opinion was expressed that reclamation should be considered with care in the future. Council also opposed the McKellar bill to repeal the federal employees classification act. On the recommendation of its committees, Council decided to take no action at this time with respect to the recommendation of the Federal Power Commission for legislation to broaden its investigatory powers and to extend its jurisdiction over holding companies. No action also was advised with reference to the McKellar bill to abolish the Shipping Board and the Hill bill to offset depreciation of foreign currencies by adding the differential to duties on imports.

A committee report suggesting a classification for listing engineers in telephone directories was received and referred to member societies. All members were requested to urge on state legislatures the desirability of allotting cooperative funds for topographic mapping and of undertaking long-time planning of public works along lines similar to those pursued by the Federal Employment Stabilization Board. Council's state committees on employment will be urged to identify themselves with the movement for better housing.

Water System Bonds Defeated In Whittier, Calif.

Voters of Whittier, Calif., defeated a proposed $100,000 bond issue for improvement of the city water system at a special election held Jan. 5. The vote on the proposal, requiring a two-thirds majority to carry, was 1,241 yes and 1,229 no. Out of a registration of more than 9,000, only 2,470 votes were cast.

New Bridge Proposed Over St. Lawrence River

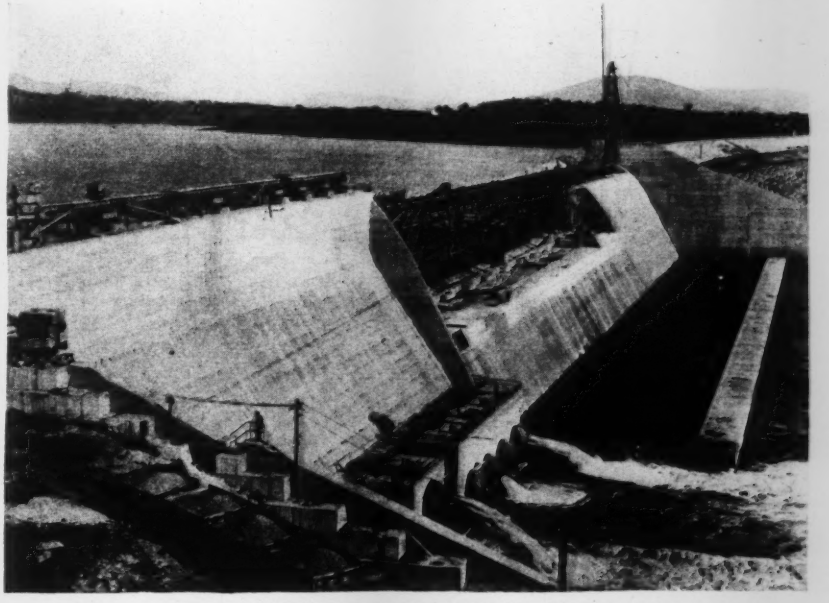
A new bridge estimated to cost $5,000,000 is proposed across the St. Lawrence River from near Ivy Lea, Leeds County, Ont., to Hill Island. Notice of application to the Ontario legislature for an act to incorporate the Thousand Island Bridge Co. has been given. During the past two years Monsarrat and Pratley, Montreal, Que., and Fay, Spofford and Thorndyke, Boston, Mass., have been retained to prepare a joint report on a proposed bridge for an international committee, of which Mayor Wright, of Kingston, Ont., is chairman.

First Electric Train Operated From New York to Philadelphia

Electric train service between New York and Philadelphia was inaugurated by the Pennsylvania Railroad on Jan. 16 in the running of four round trips of regular trains. The service will be expanded until the entire schedule is electrically operated thus completing another stage of the railroad's electrification scheme for its main line between New York and Washington.

At New York, where electric service between the Newark transfer station and the Pennsylvania station has been in operation for many years the power supply system has been changed to the 11,000 volt a.c. with the overhead catenary system employed in the new electrification work and on the New Haven Railroad.

In the Philadelphia region the new system has been in operation between Trenton and Wilmington, Del., for some time.



HUME DAM ON THE MURRAY RIVER, AUSTRALIA

The Murray River Commission of Australia is engaged in raising the level of the Hume Reservoir, on the headwaters of the River Murray, to increase its capacity to 2,5,000 acre-ft. for the coming irrigation season. When the Hume weir was first used for storage about two years ago the capacity was 155,000 acre-ft. The gap left in the spillway is now being filled in. Plans call for an ultimate reservoir capacity of 1,250,000 acre-ft. The above view shows the outlet section and spillway, located at one end of the earth-fill dam. There are seven outlet valves, 7½ ft. in diameter, three of which are to be replaced in the future by turbines. The work is being jointly financed by the Commonwealth government and the governments of Victoria, New South Wales and South Australia.

Civil Engineers Approve Changes in Relief Act

PROPOSALS for changes in the Emergency Construction and Relief Act of 1932 put forward by the committee on public works of the American Society of Civil Engineers received the endorsement of the board of direction of the society at its meeting held in New York Jan. 16-17 in advance of the annual meeting of the society. Similar action, as noted elsewhere in these pages, was taken by American Engineering Council on Jan. 13.

Proposed changes

The proposed changes would eliminate the self-liquidating limitations from Section 201 (a) (1) of the Relief Act, making it read that the Reconstruction Finance Corporation is empowered to "make loans to, or contracts with, States, municipalities, and political sub-divisions of States, public agencies of States, of Municipalities, and of political subdivisions of States, public corporations, boards of commissions, and public municipal instrumentalities of one or more States, to aid in financing projects authorized under Federal, State, or municipal law which are needful and economically sound."

The section of the Act relating to loans for housing now is of little value because it is only effective where state or municipal law regulates the construction and operation of housing projects. It is proposed, therefore, to insert a clause in that section providing for the setting up by municipalities of a commission satisfactory to the R.F.C. to regulate the local housing project where no regulatory body now exists.

The section of the Relief Act providing for loans to private companies is to be expanded to read: "to make loans to private corporations to aid in carrying out the construction, replacement, or improvement of bridges, tunnels, docks, viaducts, waterworks, sewerage works, hospitals, schools, canals, and markets, devoted to public use and which are self-liquidating in character." The added words are sewerage works, hospitals and schools.

Interest rates reduced

The Act as originally passed made no definite provision for interest rates but the rates set by the R.F.C. were generally considered to be too high in relation to what the R.F.C. had to pay for money. To correct this situation it is proposed to include in the Act a provision that interest on loans to states, municipalities, etc., shall be at the lowest point consistent with the condition that the government shall be fully reimbursed for its loan.

Elimination of the self-liquidating provisions proposed by the Civil Engineers' committee would apply only to subsection (1), that is to loans to states, municipalities, etc., for "necessary public works." The provision would be left in the sections applying to housing and to loans to private companies for bridges, etc., and to limited-dividend corporations for forestry operations. For this reason the definition of what constitutes a self-liquidating project now in the Act is to be modified by cutting out the qualifying phrase "other than by taxation."

The board believes that it is desirable to amend the act by removing restrictions, leaving more matters to the discretion of the directors of the R.F.C.

To stay in Engineering Council

Following the receipt of the report of its committee appointed at the October meeting to consider the society's relations to American Engineering Council, the board of direction voted to continue its membership in Council. This action was taken in consideration of the fact that a possible reorganization of the joint activities of the major engineering societies is under consideration by the coordinating committee of the United Engineering Trustees.

Action by the board on federal matters included endorsement of the plan to set up an interdepartmental board of water resources as approved by Engineering Council, also support of Council's action on topographic surveys. A motion relating to reorganization of the federal government was tabled. The board gave its approval to the uniform mechanics lien act now being submitted to state legislatures. It also approved the share-the-work movement.

Local and student chapters

The board of direction adopted a new method of alloting funds for the support of local section activities and gave its approval to the formation of student chapters at New Mexico College of Agricultural and Mechanical Arts, Texas Technological College and Duke University.

Legality of Gas Tax Diversion Questioned in Illinois

Constitutionality of the recently enacted Illinois state law authorizing counties to issue bonds in anticipation of their one-third share of the three-cent motor fuel tax, for the purpose of providing funds for poor relief, has been questioned in a suit filed in the Sangamon Circuit Court by the Illinois Construction Council and Thomas M. Kilbride, Springfield attorney. Under the original motor fuel law, the counties as well as the state were to use their share of the tax funds for road construction. The recent amendment providing for diverting the county allotments, is effective for some eight months, ending next July.

The construction council was organized recently by road contractors for the purpose of advancing and protecting the construction industry. The council was granted a charter Jan. 11 by the Secretary of State. The suit asks for an injunction restraining the state auditor and the state treasurer from paying funds to the counties for poor relief under the motor fuel law.

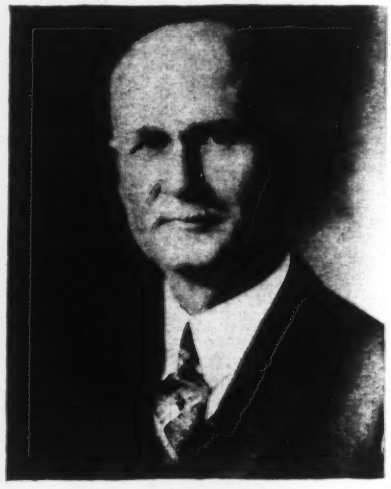
Though the suit was filed for the March term of the circuit court, it is expected that if possible proceedings will be hastened, and the suit carried to the Supreme Court during its next term.

The bill alleges that the enactment is unconstitutional because, among other reasons, it attempts to inject foreign subject matter into the motor fuel tax law. The bill also points out that several counties have bonds outstanding for road work already completed and that if the motor fuel tax funds are diverted to poor relief the redemption of the bonds will be prevented.

Alonzo J. Hammond Elected President of Civil Engineers

Alonzo J. Hammond, consulting engineer of Chicago, Ill., has been elected president of the American Society of Civil Engineers for the year 1933. Announcement of Mr. Hammond's election was made at the opening of the annual meeting of the society in New York Jan. 18.

Mr. Hammond is a native of Indiana and attended the public schools of Frankfort, Ind. He was graduated from Rose Polytechnic Institute in 1889 and took a post graduate course at Massachusetts Institute of Technology in 1890 and 1891.



Alonzo J. Hammond

Until 1898 he carried on a general engineering and architectural practice at Frankfort. In that year he joined the chief engineer's staff of the Vandalia Ry. where he remained for three years. In 1901 he went to South Bend where he was city engineer until 1910.

In 1910 Mr. Hammond went to Chicago as consulting engineer for the commission on city expenditures, reporting on the 14-ft. water tunnel at 73d St. During 1912 and 1913 he was engineer of bridges and harbors in the Department of Public Works. He was engaged as consulting engineer for the Chicago Union Station in 1914 and later became assistant chief engineer in charge of the engineering design of that structure. He resigned this connection in 1922 to join James O. Heyworth, Inc., as chief engineer and for three years was active in the design and construction of hydro-electric plants. Since 1924 he has been in private practice as a consulting engineer in Chicago.

Mr. Hammond served as director of the society in 1926-28 and as vice-president in 1929-1930.

Announcement was also made at the meeting of the election of the following vice-presidents and directors of the Society: vice-president, to serve two years, Frank O. Dufour, consulting engineer to the United Engineers & Constructors, Inc., Philadelphia, and Frank G. Jonah, chief engineer of the St. Louis, San Francisco Ry. Co., St. Louis, Mo.; directors, to serve three years, J. P. H. Perry and James F. Sanborn, both of New York, N. Y.; Henry J. Sherman, Camden, N. J.; Ralph J. Reed.

Los Angeles, Calif.; W. W. Horner, St. Louis, Mo., and Edward N. Noyes, Dallas, Texas.

The annual awards of the society's prizes and medals were made to the following members: David L. Yarnell and Floyd A. Nagler received the J. James R. Croes medal for their paper entitled "Effect of Turbulence on the Registration of Current Meters"; Clifford Allen Betts received the Thomas Fitch Rowland prize for his paper, "Completion of Moffat Tunnel of Colorado"; Earl A. Brown, the James Laurie prize for his paper "The Chesapeake & Delaware Canal"; Fred Lavis, the Arthur M. Wellington prize for "Highways as Elements of Transportation"; and Arthur R. C. Markl the Collingwood prize for juniors for his paper entitled "The Shannon Power Development in the Irish Free State."

World Power Conference To Be Held in Sweden

Preparatory work is under way by the organizing committee of the World Power Conference which is to meet in Sweden between June 23 and July 10, 1933. The conference will be a special meeting, dealing with the energy problems of large industries and transport. Participation and collaboration of 15 countries outside Scandinavia has been hitherto assured. More than 170 reports to be published at the meeting have so far been announced.

The first plenary World Power Conference was held in London in 1924; the next in Berlin, 1930; while there have also been sectional meetings with concentrated programs in Basle in 1926 and in London in 1928.

American Society of Civil Engineers Confers Honorary Memberships

THREE distinguished members of the American Society of Civil Engineers had honorary membership conferred on them at the opening of the Society's annual meeting in New York on Jan. 18. The members so honored are Charles L. Strobel, John E. Greiner and Lincoln Bush. Their election to honorary membership took place at the meeting of the board of direction last October at Atlantic City.

Lincoln Bush, consulting engineer of New York City, was born in Cook County, Ill., on Dec. 14, 1860. He was graduated from the Cook County Normal School in 1881 and from the University of Illinois in 1888. After a few years spent in teaching he entered the engineering profession. After holding various positions in the Middle West, he became bridge engineer for the Delaware, Lackawanna & Western R.R., later serving as chief engineer. Since 1909 most of Mr. Bush's time has been devoted to consulting engineering and contracting, especially in the fields of railroads and bridges. During the war he was associate officer in charge of the engineering division of the construction division of the army responsible for the terminal facilities installed at Boston, Brooklyn, Port Newark, Philadelphia, Norfolk, Charleston, and New Orleans. He served the Society as director from 1912 to 1914, treasurer from 1915 to 1916, vice-president from 1924 to 1925 and was president in 1928.

John E. Greiner, consulting engineer of Baltimore, Md., was born in Wilmington, Del., in 1859. He was graduated from Delaware College in 1880. From 1885 to 1908, with the exception of one year, he was in the service of the Baltimore & Ohio R.R. in various capacities from chief draftsman to assistant chief engineer. In 1908 he entered private practice in Baltimore and has been retained as consulting engineer on more than 300 important bridges and other engineering structures. He was a member of the American Railroad Commission to Russia appointed in 1917 by President Wilson. As bridge expert of this commission he passed upon the strength and carrying capacity of all bridges on the Trans-Siberian and Russian railways.

Charles L. Strobel was born in Cincinnati, Ohio, on Oct. 6, 1852. After attending the public schools of Cincinnati he entered the Royal Institute of Technology at Stuttgart, Germany, in 1869 which he attended for four years. After returning to the United States Mr. Strobel became assistant engineer of the Cincinnati Southern Ry. in 1874, in charge of theoretical work and design for the superstructure of bridges and viaducts. He was in that position for four years. During the next 15 years he was successively consulting engineer for the Keystone Bridge Co., Carnegie, Phipps & Co., and the Chicago, Milwaukee & St. Paul Ry. From 1893 to 1905 he was in business as a contracting engineer and the firm was later carried on as a corporation under the name of the Strobel Steel Co. Mr. Strobel withdrew from the contracting business in 1926. His most outstanding work was that of author, compiler and editor of the original and several later editions of the Carnegie Handbook. He also designed the first standard sections for I-beams and channels and first proposed the rolling of Z-bars and the use of Z-bar columns. Mr. Strobel served as director of the society in 1886 and in 1894. From 1911 to 1912 he was vice-president.

Hoover Dam Notes

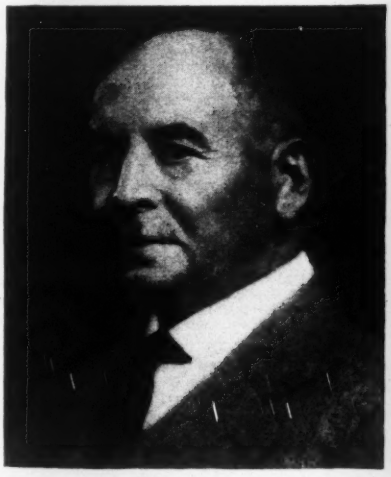
Bids are to be opened on January 27 at the Denver office of the Reclamation Bureau for the furnishing of 8 welded steel-cylinder gates, 32 ft. in diameter by 10 ft. high, for installation in the intake towers.

* * *

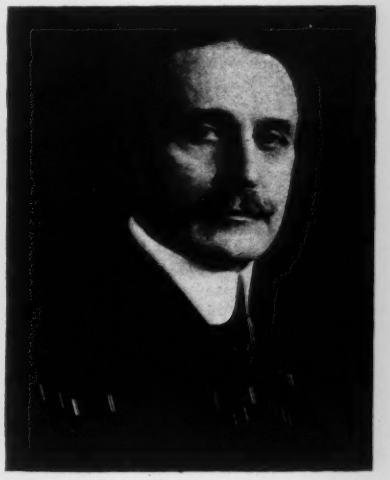
Further efforts have been made by the authorities of Clark County, Nevada, to collect taxes from residents and business firms in Boulder City. Written notices were issued announcing the sale of taxpayer property sufficient to satisfy taxes but Six Companies, Inc., obtained a temporary injunction from the federal court.

* * *

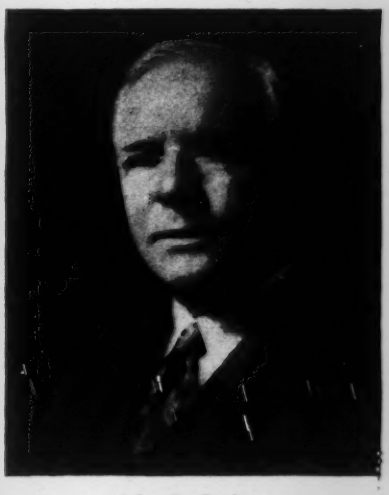
Excavation was started during the week ended Jan. 7 at the Arizona power house site and was continued on both dam abutments. Construction of a protection wall on the Arizona side near the canyon rim was begun. Work at the sites of the Nevada intake towers was resumed January 4. Excavation for the Arizona valve house, the upper adit and the connecting road is 85 per cent complete.



Lincoln Bush



Charles L. Strobel



John E. Greiner

Mississippi States Join Chicago In Sanitary District Defense

Six Mississippi Valley states, seeking greater diversion of water from Lake Michigan at Chicago, came to the support of Illinois and the Chicago Sanitary District at the opening of Federal hearings at Chicago Jan. 12 in the action brought by six Great Lakes states.

The hearings are before Edward F. McClennen of Boston, special master for the United States Supreme Court. He granted the participation of the Mississippi Valley states—Missouri, Kentucky, Tennessee, Arkansas, Mississippi and Louisiana—over the objections of counsel for New York, Wisconsin, Minnesota, Michigan, Ohio and Pennsylvania, which brought the receivership action.

The six lake states seek the appointment of a commissioner to take over the affairs of the sanitary district, and allege delinquency on the part of the district officials in carrying out the Supreme Court's decree of April 21, 1930, which limits ultimate diversion of water from Lake Michigan by the district to 1,500 sec.-ft.

Permission for the Mississippi Valley states to intervene is subject to future confirmation by the Supreme Court.

The Mississippi Valley states contend that the diversion of 1,500 sec.-ft. after Dec. 31, 1938, as prescribed by the Supreme Court, will not serve the requirements of navigation in the Lakes-to-the-Gulf Waterway. The Illinois section of the waterway, comprised in the Sanitary District's drainage canal, is scheduled to be opened for commercial traffic this year.

Chicago Sanitary Dist. Reports Little Work to Supreme Court

Due to lack of funds little construction work is reported as accomplished in the semi-annual report of the Sanitary District of Chicago to the U. S. Supreme Court as of Jan. 1. Design has proceeded with a greatly reduced staff on the Calumet and West Side Projects and on studies for the Southwest Side Project.

Results from a large experimental sludge dewatering and incinerating unit, started in August, are reported to be "quite satisfactory and indicate the probability that incineration of sludge is feasible and economical where the quantities to be handled are large." This means a probable replacement of digestion and sludge drying beds at the West Side, Southwest Side and Calumet plants; resulting in considerable saving in construction costs, in economy of space and time of construction. As to space, it may now be feasible to build the Southwest Side plant on the ground at the West Side plant reserved for digestion and sludge beds. Financially a saving of $9,775,000 is indicated as probable if incineration is adopted for the three plants above noted.

The financial situation of the District is reported to be much the same as noted in the last two semi-annual reports. For unsold authorized bonds of $43,000,000 no reasonable offer from any source can be obtained. Defaults of $13,772,902.50 in interest and principal are noted but against this are unpaid taxes for 1928, 1929, 1930 and 1931 of $40,708,000, a normal income of the District for two years. Bills for the 1931 taxes of $18,876,000 are about to be sent out. The R.F.C. was asked for $36,450,000 and to aid the eligibility of the proposed loan the District has caused an amendment to the Act to be introduced in Congress eliminating the "other than by taxation" requirement. As to tax collections the taxpayers "strike" over validity of the 1928, 1929 and 1930 levies has been broken, the resisting organizations are disintegrating and owners of large blocks of valuable real estate are paying their taxes.

Reduction in contract prices, the report states, has already made a saving over estimates of 25 per cent in work estimated at $19,834,000. Revised estimates of future treatment construction amount to $154,350,000 of which there is now under contract $8,810,500. If the savings by dewatering and incineration can be counted on the total future work will be reduced from $154,350,000 to $135,765,000.

By permit from the Secretary of War the net diversion of water from Lake Michigan is limited to an annual average of not more than 6,500 sec.-ft. up to Dec. 31, 1935. The average for 1932 was 6,453 sec.-ft.

Moffat Water Tunnel Bids Not Acted on by Water Board

The Denver Board of Water Commissioners, Denver, Colo., January 12 decided not to open the bids that had been received for steel pipe to bring water through the three miles of steel pipe via the pioneer bore of the Moffat tunnel. It is expected that bids will be called again in a few weeks. According to the water department officials, major changes are being made in the plans, involving the possible use of concrete.

Columbus' Request for Delay In Sewage Disposal Refused

In an effort to arrive at some definite decision in relation to the sewage disposal problem of Columbus, Ohio, a meeting was held on Jan. 13 between the city officials and the Ohio State Health Council. The city officials asked an extension of time on the order issued by the State Health Department several years ago for the city to remedy its sewage disposal plant. The time limit on the original order was Jan. 15, 1933. A recent decision of the Ohio supreme court has ruled that the order of the state health department was mandatory.

Although the State Health Council refused to grant an extension of time it agreed to take no action against the city or the city authorities if the question of building the Columbus sewage plant is cleared up by April 14. At the election in November, 1932 a proposition to issue bonds in the sum of $3,500,000 for the erection of a new sewage disposal plant was defeated. Many solutions of the problem have been suggested but none have been adopted. The city engineering staff has designed an activated sludge plant but it has been impossible so far to finance its construction.

One of the plans submitted involves the taking over of the existing plant by a private company which would enlarge it so as to be satisfactory for present needs and operate it under contract with the city.

SOCIETY CALENDAR

AMERICAN CONCRETE INSTITUTE, annual meeting, Chicago, Feb. 21-24.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, N. Y., Jan. 18-21.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, annual convention, Cincinnati, Ohio, Jan. 20-25.

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago, Ill., Jan. 24-26.

CONSTRUCTION LEAGUE OF THE UNITED STATES, Detroit, Mich., Policy committee assembly, Jan. 21.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Ottawa, Ont., Feb. 7-8.

MINNESOTA SURVEYORS AND ENGINEERS SOCIETY will meet Feb. 23 and 24 in St. Paul for its 38th annual convention. Esthetics in engineering, bridges, highways, soils, water supply, economic planning, contract relations and transportation problems are scheduled in the program. L. P. Zimmerman, St. Paul, is secretary.

PURDUE UNIVERSITY'S nineteenth annual road school will be held at the University, Lafayette, Ind., Jan. 23-27. It will be under the direction of the Engineering Extension Department and the School of Engineering with the cooperation of the State Highway Commission, County Highway Superintendents' Association, County Surveyors' and County Engineers' Association and the Highway Materials and Equipment Association. The school is open to anyone interested in road and street problems. There is no registration fee.

COLORADO SOCIETY OF ENGINEERS will hold its fifth annual convention Jan. 21 in Denver. Preceding and in conjunction with it will be held open house at U. S. Bureau of Standards Laboratory and a series of papers on "Mass Concrete Research in Connection with the Design and Construction of the Hoover Dam." Also preceding the convention Jan. 19 and 20 will be held the Highway Engineers Conference at the University of Colorado, Boulder. C. M. Lightburn is secretary of the Colorado Society of Engineers.

AMERICAN TOLL BRIDGE ASSOCIATION held its annual meeting at Camden, N. J., Jan. 16-17. The papers presented for discussion included a survey of the toll bridge field, legal phases of toll bridge operation, the effect of toll rates on bridge income and toll bridge operation. The committee on insurance and on accounting submitted reports and special papers relating to highway traffic and highway bridges and the history of the Wheeling suspension bridge were presented. D. B. Steinman is president of the association and P. K. Schuyler, Federal Bridge Co., Washington, D. C., is secretary.

ILLINOIS SOCIETY OF ENGINEERS will hold its 48th annual meeting Jan. 23-25 in Chicago. Thirty papers will be presented at two general sessions and eight section meetings. At a public affairs session six addresses will stress R.F.C. public affairs and the engineer, the present economic situation, taxing, bonding and administration, registration of engineers and welfare. Technical papers will relate to water supply, sewerage, structural work, coal mining, electrical research, surveying drainage, roads and pavements. Prof. H. E. Babbitt, University of Illinois, Urbana, is secretary.

METROPOLITAN SECTION, American Society of Civil Engineers, at a meeting held on Jan. 11, was addressed by Jay Downer, chief engineer, Westchester County Park Commission. Mr. Downer described work of the commission in developing its park and parkway system, laying special emphasis upon the lessons learned as to major through highway and by-pass highways. Trunk highways have been found to be a detriment rather than an asset to abutting property, he said, and the time has passed when part of the cost should be assessed against such property. He cited some highways in Westchester County and the superhighway at Detroit as examples. Mr. Downer said further that no highway should be wider than six lanes without a division between opposing lanes.

Personal Notes

ERNST LIEBERMAN of Lieberman & Hein, consulting engineers, Chicago, has been appointed chief highway engineer of Illinois, vice Frank T. Sheets, relieved of duty by Governor Horner.

FRED T. PAUL, bridge and paving engineer, Minneapolis, Minn., has been appointed city engineer to succeed N. W. ELSBERG, appointed state highway engineer by Governor Olson. Mr. Paul has been with the city of Minneapolis 24 years.

GEORGE M. SHEPARD, chief engineer of St. Paul, Minn., has been appointed a member of the Metropolitan Drainage Commission by Governor Floyd B. Olson to succeed Oscar Claussen, deceased. Mr. Shepard was one of the original members of this commission but resigned in March, 1929, when he entered the contracting field.

FRANK T. SHEETS, chief highway engineer, Illinois Division of Highways was relieved of duty by the incoming administration on Jan. 13. Mr. Sheets has been with the department for 26 years starting as an engineering clerk, then rodman, bridge designer, office engineer of bridges, assistant maintenance engineer, bridge engineer, engineer of design in charge of road and bridge design, surveys, estimates, specifications and contracts, state superintendent of highways. Since his appointment as chief highway engineer in 1924 he has directed the expenditure of more than $300,000,000. Mr. Sheets is president of Barker, Flavin, Sheets & Wallace, consulting engineers, with offices in Chicago.

Obituary

JAMES WILLIAM SCOTT HENDERSON, a civilian attaché of the United States Army Engineering Corps in charge of seawall extension at Galveston and harbor maintenance work there for several years, died on Jan. 9 at the age of 70. He had retired from the engineering service last April.

JOHN J. HARTLEY, western division chief engineer of the Link-Belt Co., Chicago, Ill., was shot to death on Dec. 31. He was 39 years old. Mr. Hartley had been with the Link-Belt Co. for the past 23 years.

HENRY L. LANE, who for 30 years had been president of Lane Bros. Co., contractors, died at the age of 65 at his home near Altavista, Va. Mr. Lane had supervised the construction of the Ocmulgee river dam near Macon, Ga. His firm also constructed part of the Virginian Railway and part of the Welland ship canal.

EDWARD A. TOOLE, superintendent of the New Haven Water Co., died on Jan. 9 at his home in New Haven, Conn., after a brief illness.

Engineering Contracts and Capital

FOLLOWING TWO WEEKS of activity far above the average, heavy engineering construction contracts reported for the past week slumped to $12,265,000, the lowest weekly volume reported since last March, and less than half of the previous week's totals. The average of the past four weeks is $23,187,000, and for the month of January, 1932, the weekly average was $23,395,000. A falling off in highway awards from $10,387,000 the previous week to $3,827,000 the current week is responsible for much of the drop in contract volume. Federal awards held to the low figure of $2,309,000. Public building contracts, amounting to $1,918,000, were but half of the previous week's volume. Private contracts fell from a 9-million-dollar volume the week before to $2,383,000 for the current week. The greatest loss was in the field of industrial building. The largest single contract reported during the week was for a sewage disposal system for Lancaster, Pa., $900,000.

A few large projects entered the proposed list. A hydro-electric development is planned in Indiana to cost $2,000,000. Hartford, Conn., is planning betterments to its water distribution system, estimated at $2,000,000. Plans were announced for a parcel post annex at Richmond to cost $1,000,000. Bids will be called about March 7 for a water filtration plant at Chicago, estimated at $3,500,000.

New capital issues reported during the week total $7,400,000, of which $5,500,000 represents a single corporate issue. The Reconstruction Finance Corp. approved seven self-liquidating loans aggregating $1,991,000, bringing the approved total to date to $147,651,000. No R.F.C. loans were actually made during the week, this total remaining at $17,753,000.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Jan., 1932	Four Weeks	Week Jan. 19, 1933
Federal government	$4,155	$2,541	$2,309
State and municipal	9,289	15,868	7,573
Total public	$13,444	$18,409	$9,882
Total private	9,951	4,728	2,383
Week s total	$23,395	$23,137	$12,265
Cumulative to date:			
1932		$70,185	
1933		78,145	

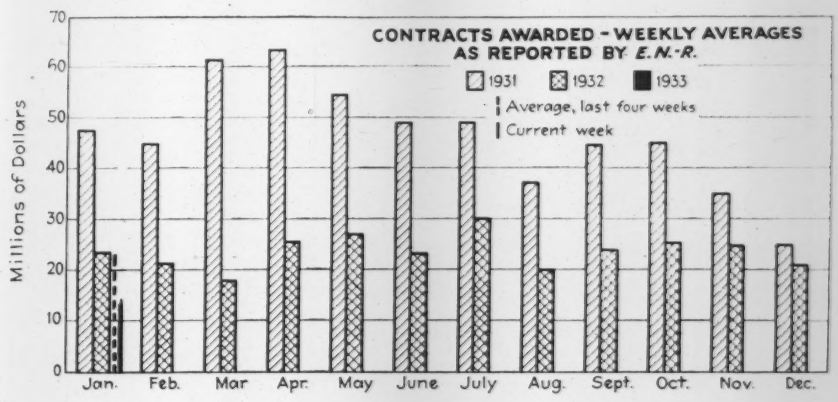
NEW PRODUCTIVE CAPITAL

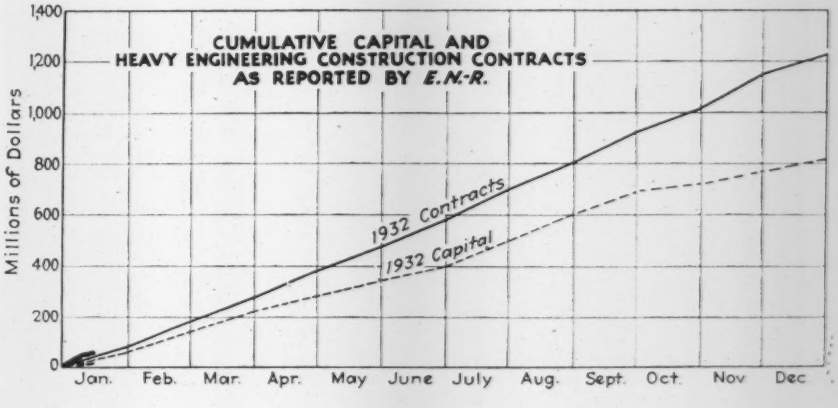
(Thousands of Dollars)

	Weekly Average Jan., 1932	Four Weeks	Week Jan. 14, 1933
R.F.C. loans made			
New capital issues	$17,750	$9,000	$7,400
Total	$17,750	$9,000	$7,400
Cumulative to date:			
1932		$35,500	
1933		22,900	
R.F.C. self-liquidating loans:			
Approved current week			$1,941
Approved to date (including 1932)			147,651
Actual loans made (including 1932)			17,753

ENR Cost and Volume Index

E.N.-R. Cost		E.N.-R. Volume	
January, 1933	158.44	December, 1932	113
December 1932	158.46	November, 1932	137
January, 1932	162.48	December, 1931	133
1932 (Average)	156.97	1932 (Average)	127
1931 (Average)	181.35	1931 (Average)	220
1930 (Average)	202.35	1930 (Average)	260
1913 Average	100		

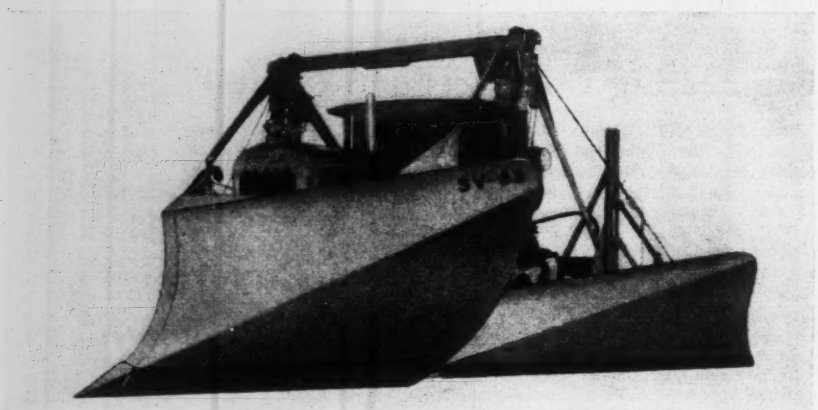




Construction Equipment and Materials

Hydraulic Snow Plow

The LaPlant-Choate Manufacturing Co., Inc., Cedar Rapids, Iowa, announces a new series of hydraulic operated snow plows for use on Caterpillar tractors. The plows include a newly designed wing hoist which provides greater facilities for pushing out side banks of snow. The wing is lifted simultaneously at three points: at the front of the wing, at the rear and at the point on the tractor where the wing braces are attached. The V nose and wings are raised and lowered by means of hydraulic pressure obtained from the tractor power take-off.



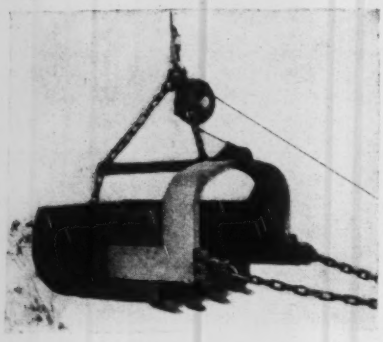
Laplante-Choate snow plow

New Bucket for Light Soils

The Page Engineering Company, Chicago, Ill., announces a new series of buckets designated as class "LM," especially designed for digging light soils. The side walls and back are formed of thinner gage steel plate than the bucket bottom, with the joint "apron" welded and the seams ground down smooth. The manufacturer states that this construction insures strength where strength is needed, and also gives smooth clean surfaces that shed dirt quickly and easily.

The arch and bump plates are welded and securely hot riveted to the walls of the bucket. The arch comprises two channels facing inward and joint welded, leaving no openings. The lip is of forged steel and is heat treated. The cutting edge is machined and the plate connections are recessed to eliminate overlaps. The teeth are of new design, fastening to the lip in a manner that prevents their working loose or becoming wobbly. The bucket can be used with or without the teeth.

Smooth surfaces of Page's new bucket shed dirt quickly.



New Equipment in Brief

Welding Machine. A new four-bearing, self-excited, dual-control arc-welding machine, known as model "S.A.", is announced by the Wilson Welder & Metals Co., Inc., North Bergen, N. J. It has been designed to provide the high amperage and arc voltage required in speed and shielded-arc welding. A flexible coupling between the two units facilitates the changing of the motor or generator in case of failure.

Concrete Surfacer. A new surfacer for wet-rubbing all kinds of concrete construction, known as the Berg Water Feed Concrete Surfacer, is announced by the Concrete Surfacing Machinery Company, Cincinnati, Ohio. One of the features incorporated in the design is the water control valve at the thumb of the operator. The water outlet is in the center of the carbo-disc. Water cannot enter the gear housing.

Geared Motors. "Ideal" geared motors with the gear-reduction unit built integral with the motor, are announced by the Ideal Electric & Mfg. Co., Mansfield, Ohio. No motor coupling is used as the high-speed gear is mounted directly upon the motor shaft. The units are available in all gear ratios from 2.09 to 1 up to 376 to 1, giving output speeds of from 861 r.p.m. to 4.7 r.p.m., using the standard 1,800 r.p.m. motor supplied with these units. Geared motors are supplied in all horsepowers from ¾ to 20.

Asphalt Mixer. A new asphalt mixer of the twin shaft, pug mill type, is announced by the Asphalt Equipment Co., Inc., Scottdale, Pa. The mixer has a capacity of 4,000 pounds or 40 cu.ft. The mixer ends are equipped with glands and stuffing boxes, to prevent sand and stone from working out into the mixer bearings. The gate is of manganese steel and is easily replaced. It is supported on adjustable steel guides. The gate operating cylinder is of seamless steel and is furnished for either steam or air operation. The mixer is built in the following sizes: 500, 1,100, 2,000, 3,000, 4,000, and 6,000 lb.

New Publications

Dragline Buckets. A bulletin issued by Bucyrus-Erie Co., of South Milwaukee, Wis., describes their Red Arch dragline buckets (Type X). The complete range of sizes (from ½ to 8 yd.) is listed with weights and complete dimensions.

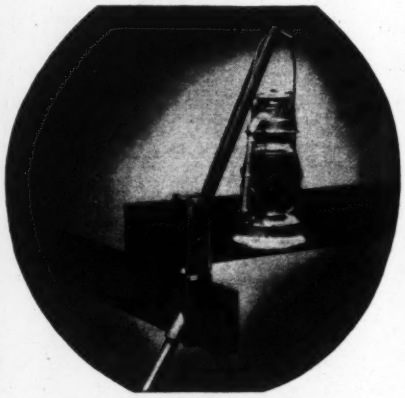
Weed Burner. An 8-page pamphlet has been published by the Aeroil Burner Co., Inc., Park Ave. at 13th St., West New York, N. J., describing the Aeroil weed burner. The device described burns kerosene, distillates, diesel oil or light furnace oil to produce a flat flame 7 in. wide, 15 in. long. The equipment described includes a number of sizes from a hand burner to a wheelbarrow size.

Welding Electrodes. Numerous applications of inorganic flux-coated welding electrodes are described in a booklet published by the Metal & Thermit Corp., 120 Broadway, New York, N. Y. The new booklet describes the welding of mild steel and boiler plate, stainless steel alloys, manganese steel, high carbon steel and stainless iron. The building up of railway rail ends, special manganese track work as well as the repair of castings and heavy parts is also covered.

Wire Rope. "The Splicing of Wire Rope" is the title of a 36-page pamphlet published by John A. Roebling's Sons Co., Trenton, N. J. The primary object of the booklet is to present a description of the methods of splicing wire rope employed in the shops of the John A. Roebling's Sons Co. Each step of the work is covered with illustrations designed to be of practical service to users of wire rope. Four types of splices are shown: standard long splice, Chicago or tied splice, long splice for ropes with an independent wire rope center, and thimble splice.

Swiveling Guard Rail Holder

A new type of trench guard has been announced by the Cleveland Trencher Co., 20,100 St. Clair Ave., Cleveland, Ohio. Designed for use with 2x6 in. guard-rail planks, the trench guard includes a pair of swivelling guard rail holders made of rustproof malleable iron, two ¾ in. galvanized supporting pipes, a lantern holder and red flag. The guard-rail holders swivel in any direction. The manufacturer states that the device permits a complete, unbroken fence around an excavation or alongside trenches, regardless of their contours.



New guard rail holder for trench guards